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<p>(21) International Application Number: PCT/US97/06989</p> <p>(22) International Filing Date: 25 April 1997 (25.04.97)</p> <p>(30) Priority Data:</p> <table border="0"> <tr><td>60/016,525</td><td>3 May 1996 (03.05.96)</td><td>US</td></tr> <tr><td>60/016,527</td><td>3 May 1996 (03.05.96)</td><td>US</td></tr> <tr><td>60/017,062</td><td>3 May 1996 (03.05.96)</td><td>US</td></tr> <tr><td>60/017,059</td><td>3 May 1996 (03.05.96)</td><td>US</td></tr> <tr><td>60/017,060</td><td>3 May 1996 (03.05.96)</td><td>US</td></tr> <tr><td>60/016,526</td><td>3 May 1996 (03.05.96)</td><td>US</td></tr> <tr><td>60/016,531</td><td>3 May 1996 (03.05.96)</td><td>US</td></tr> <tr><td>60/016,528</td><td>3 May 1996 (03.05.96)</td><td>US</td></tr> <tr><td>60/027,902</td><td>3 May 1996 (03.05.96)</td><td>US</td></tr> <tr><td>60/027,899</td><td>3 May 1996 (03.05.96)</td><td>US</td></tr> </table> <p>(71) Applicant: THE PROCTER & GAMBLE COMPANY [US/US]; One Procter & Gamble Plaza, Cincinnati, OH 45202 (US).</p>		60/016,525	3 May 1996 (03.05.96)	US	60/016,527	3 May 1996 (03.05.96)	US	60/017,062	3 May 1996 (03.05.96)	US	60/017,059	3 May 1996 (03.05.96)	US	60/017,060	3 May 1996 (03.05.96)	US	60/016,526	3 May 1996 (03.05.96)	US	60/016,531	3 May 1996 (03.05.96)	US	60/016,528	3 May 1996 (03.05.96)	US	60/027,902	3 May 1996 (03.05.96)	US	60/027,899	3 May 1996 (03.05.96)	US	<p>(72) Inventors: PRAMOD, Kakumanu; 7986 Kingfisher Lane, West Chester, OH 45069 (US). PANANDIKER, Rajan, Keshav; 6484 Oregon Pass, West Chester, OH 45069 (US). GHOSH, Chanchal, Kumar, 7005 Pinemill Drive, West Chester, OH 45069 (US). WATSON, Randall, Alan; 14 Pendery Avenue, Cincinnati, OH 45215 (US). KONG-CHAN, Josephine, Ling; 12106 Paulmeadows Drive, Cincinnati, OH 45249 (US). DE BUZZACCARINI, Francesco; 17A, rue Vilain XIII, B-1050 Brussels (BE).</p> <p>(74) Agents: REED, T., David et al.; The Procter & Gamble Company, 5299 Spring Grove Avenue, Cincinnati, OH 45217 (US).</p> <p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).</p> <p>Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>
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<p>(54) Title: LIQUID DETERGENT COMPOSITIONS COMPRISING SPECIALLY SELECTED MODIFIED POLYAMINE POLYMERS</p> <p>(57) Abstract</p> <p>Laundry detergent compositions that provide fabric appearance benefits to all fabric comprising modified polyamine agents and other selected fabric appearance agents, and a method for providing these benefits to fabric by contacting fabric articles with a water soluble and/or dispersible, modified polyamine having functionalized backbone moieties.</p>																																

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LIQUID DETERGENT COMPOSITIONS COMPRISING SPECIALLY SELECTED MODIFIED POLYAMINE POLYMERS

PRIOR HISTORY

This application claims priority to the following pending applications: U.S. Serial No. 60/016,527, filed May 3, 1996; U.S. Serial No. 60/017,062, filed May 3, 1996; U.S. Serial No. 60/016,525, filed May 3, 1996; U.S. Serial No. 60/017,059, filed May 3, 1996; U.S. Serial No. 60/017,060, filed May 3, 1996; U.S. Serial No. 60/016,526, filed May 3, 1996; U.S. Serial No. 60/016,531, filed May 3, 1996; U.S. Serial No. 60/016,528, filed May 3, 1996; U.S. Serial No. 60/027,902, filed October 7, 1996; and U.S. Serial No. 60/027,899, filed October 7, 1996.

FIELD OF THE INVENTION

The present invention relates to liquid laundry detergent compositions that provide fabric appearance benefits to fabric under a variety of soil conditions. The compositions herein comprise specially selected modified polyamine fabric appearance agents. The present invention also relates to a method for providing fabric appearance benefits to fabrics by contacting fabric articles with a water soluble and/or dispersible, modified polyamine.

BACKGROUND OF THE INVENTION

A wide variety of fabric appearance agents for use in domestic and industrial fabric treatment processes such as laundering, fabric drying in hot air clothes dryers, and the like are known in the art. Various fabric appearance agents, including soil release agents, dispersants, surfactants, fabric softeners, and dye transfer inhibitors, have been commercialized and are currently used in detergent compositions and fabric softener/antistatic articles and compositions.

Extensive research in this area has yielded significant improvements in the effectiveness of the various fabric appearance agents, providing enhanced product performance and formulatability. However, no one single compound has been identified which can perform a number of these fabric appearance enhancements. Thus, formulators must pick and choose among several technologies to achieve the overall performance expected by consumers in a cost effective manner. The problem is compounded in liquid detergents because of the potential interactions of the various agents in an aqueous solution.

Moreover, many of these conventional fabric appearance agents do not provide enhanced performance on both hydrophobic and hydrophilic soils and stains. Tea stains are hydrophilic. Dirt and tomato stains are hydrophobic.

Thus, until now the development of an effective, all-around fabric appearance agent for use in a laundry detergent has been elusive. Attempts by others to apply the paradigm of matching the structure of a polymer with the structure of the fabric, a method successful in the polyester soil release polymer field, has nevertheless yielded marginal results.

It has now been surprisingly discovered that effective fabric appearance agents can be prepared from certain modified polyamines. This unexpected result has yielded compositions that are key to the present method for providing several fabric appearance benefits, i.e., soil removal, dispersal of soils, and dye transfer inhibition, once available to only with the use of several individual laundry additives. The process or method of the present invention also provides benefits on all types of soils and stains.

The process or method of the present invention is especially effective when the laundry detergent compositions disclosed herein are liquid. The liquid detergents can have a wide range of viscosity and may include heavy concentrates, pourable "ready" detergents, or light duty fabric pre-treatments.

The modified polyamines disclosed in the present method are compatible with other laundry detergent additives and adjuncts. In fact, it is believed that the polyamines of this invention actually compliment and enhance the performance of other detergent additives, such as surfactants and additives that before now can cause negative dye transfer problems.

BACKGROUND ART

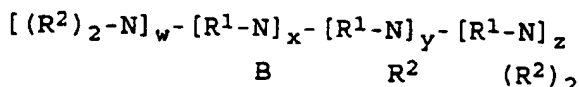
U.S. Patent 4,548,744, Connor, issued October 22, 1985; U.S. Patent 4,597,898, Vander Meer, issued July 1, 1986; U.S. Patent 4,877,896, Maldonado, et al., issued October 31, 1989; U.S. Patent 4,891,160, Vander Meer, issued January 2, 1990; U.S. Patent 4,976,879, Maldonado, et al., issued December 11, 1990; U.S. Patent 5,415,807, Gosselink, issued May 16, 1995; U.S. Patent 4,235,735, Marco, et al., issued November 25, 1980; WO 95/32272, published November 30, 1995; U.K. Patent 1,537,288, published December 29, 1978; U.K. Patent 1,498,520, published January 18, 1978; German Patent DE 28 29 022, issued January 10, 1980; Japanese Kokai JP 06313271, published April 27, 1994. See also U.K. 1,314,897; U. S. Patent No. 3,897,026; U.S. Patent No. 3,912,681; U.S. Patent No. 3,948,838 issued to Hinton, *et alia* describes high molecular weight (500,000 to 1,500,000) polyacrylic polymers for soil release; U.S. Patent 4,559,056; U.S. Patent No. 4,579,681; U.S. Patent No. 4,614,519.

Examples of alkoxylated polyamines and quaternized alkoxylated polyamines are disclosed in European Patent Application 206,513 as being suitable for use as soil dispersants, however their possible use as a cotton soil release agent is not disclosed.

SUMMARY OF THE INVENTION

Submitted herein are liquid laundry detergent compositions comprising:

- a) at least about 0.1% by weight, of a deterative surfactant selected from anionic surfactants, nonionic surfactants, or mixtures thereof;
- b) at least about 0.05% by weight, of a water-soluble or dispersible, modified polyamine agent, said agent comprising a polyamine backbone corresponding to the formula:



wherein each R^1 is independently C_2 - C_5 alkylene, alkenylene or arylene; each R^2 is independently H, or a moiety of formula $OH[(CH_2)_xO]_n$, wherein x is from about 1 to about 8 and n is from about 10 to about 50; w is 0 or 1; x+y+z is from about 5 to about 30; and B represents a continuation of this structure by branching; and wherein said polyamine before alkylation has an average molecular weight of from about 300 to about 1,200; and

- c) one or more additional deterative additives selected from the group consisting of amylase, deterative amine, cationic surfactants, antiredeposition agents, antifading agent, dye fixative agents, prill/fuzzing reducing agents, and mixtures thereof.

The detergent compositions herein can comprise additional adjunct ingredients selected from the group consisting of builders, optical brighteners, soil release polymers, dye transfer inhibitors, polymeric dispersing agents, non-amylase enzymes, suds suppressers, dyes, perfumes, colorants, filler salts, hydrotropes, and mixtures thereof.

In preferred embodiments, R^1 is C_2 - C_4 alkylene, more preferably ethylene; R^2 is $OH[CH_2CH_2O]_n$, wherein n is from about 15 to about 30, more preferably n is about 20. The average Molecular Weight of the polyamine before alkylation is from about 300 to about 1200, more preferably from about 500 to about 900, still more preferably from about 600 to about 700, even more preferably from about 600 to about 650.

The present invention further relates to a method of providing dye transfer inhibiting and other fabric appearance benefits to fabric by contacting said fabric with a laundry composition comprising:

- a) at least about 0.05% by weight, of a water-soluble or dispersible, modified polyamine agent as disclose above; and
- b) one or more additional deterative additives selected from the group consisting of selected amylases, selected deterative amines, selected cationic surfactants,

antiredeposition agents, antifading agent, dye fixative agents, prill/fuzzing reducing agents, and mixtures thereof.

The detergent compositions of this invention may be in liquid, gel or structured liquid form.

All percentages, ratios and proportions herein are by weight, unless otherwise specified. All temperatures are in degrees Celsius ($^{\circ}$ C) unless otherwise specified. All documents cited are in relevant part, incorporated herein by reference.

DETAILED DESCRIPTION OF THE INVENTION

Preferred laundry detergent compositions of this invention comprise:

- a) from about 0.1% to about 95% by weight, of an anionic deterative surfactant, preferably selected from alkyl sulfates, alkyl alkoxy (preferably ethoxy) sulfates, and mixtures thereof;
- b) at least about 0.1% to about 95% by weight, of a nonionic deterative surfactant, preferably selected from polyhydroxy fatty acid amides and alky ethoxylates;
- c) from about 0.05% to about 15% by weight, preferably from about 0.1% to about 10%, of a water-soluble or dispersible modified polyamine fabric appearance agent of this invention;
- d) one or more additional deterative additives selected from the group consisting of amylase, deterative amine, cationic surfactants, antiredeposition agents, antifading agent, dye fixative agents, prill/fuzzing reducing agents, and mixtures thereof; and
- e) the balance carrier and adjunct ingredients.

The compositions of this invention preferably have a pH of about 6 to about 12, more preferably from about 7.0 to about 10.5, when measured as a 10% solution in water.

Modified Polyamines -The present invention employs an "effective amount" of the polyamine fabric appearance agent herein to improve the performance of cleaning compositions which contain other adjunct ingredients. By an "effective amount" herein is meant an amount which is sufficient to improve, either directionally or significantly at the 90% confidence level, the performance of the cleaning composition against at least some of the target soils and stains. Thus, in a composition whose targets include certain food stains, the formulator will use sufficient polyamine fabric appearance agent to at least directionally improve cleaning performance against such stains. Importantly, in a fully-formulated laundry detergent the fabric appearance agents can be used at levels which provide at least a directional improvement in cleaning performance over a wide variety of soils and stains, as will be seen from the data presented hereinafter.

As noted, the fabric appearance agents are used herein in detergent compositions in combination with deterative surfactants at levels which are effective for achieving at least a directional improvement in cleaning performance. In the context of a fabric laundry composition, such "usage levels" can vary depending not only on the type and severity of the soils and stains, but also on the wash water temperature, the volume of wash water and the type of washing machine.

As can be seen from the foregoing, the amount of fabric appearance agent used in a machine-wash laundering context can vary, depending on the habits and practices of the user, the type of washing machine, and the like. In this context, however, one heretofore unappreciated advantage of the fabric appearance agents is their ability to provide at least directional improvements in performance over a spectrum of soils and stains.

The modified polyamine agents of the present invention are water-soluble or dispersible, modified polyamines. These polyamines comprise backbones that can be either linear or cyclic. The polyamine backbones can also comprise polyamine branching chains to a greater or lesser degree. In general, the polyamine backbones described herein are modified in such a manner that each nitrogen of the polyamine chain is thereafter described in terms of a unit that is substituted, quaternized, or combinations thereof.

For the purposes of the present invention the term "modification" is defined as replacing a backbone -NH hydrogen atom by an E unit (substitution) or by quaternizing a backbone nitrogen (quaternized). The terms "modification" and "substitution" are used interchangeably when referring to the process of replacing a hydrogen atom attached to a backbone nitrogen with an E unit. Quaternization may take place in some circumstances without substitution.

Preferred polymers of the present invention comprise homogeneous polyamine backbones that are totally or partially substituted by polyethyleneoxy moieties, totally or partially quaternized amines, nitrogens totally, and mixtures thereof. However, not all backbone amine nitrogens must be modified in the same manner, the choice of modification being left to the specific needs of the formulator. The degree of ethoxylation is also determined by the specific requirements of the formulator.

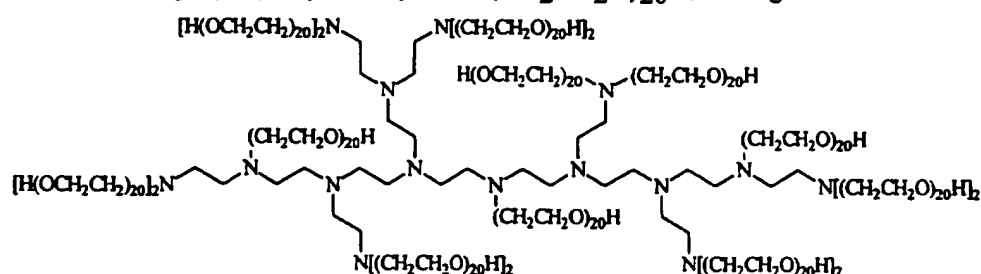
The preferred polyamines that comprise the backbone of the compounds of the present invention are generally polyalkyleneamines (PAA's), polyalkyleneimines (PAI's), preferably polyethyleneamine (PEA's), polyethyleneimines (PEI's), or PEA's or PEI's connected by moieties having longer R units than the parent PAA's, PAI's, PEA's or PEI's. A common polyalkyleneamine (PAA) is tetrabutylpentamine. PEA's are obtained by reactions involving ammonia and ethylene dichloride, followed by fractional

distillation. The common PEA's obtained are triethylenetetramine (TETA) and tetraethylenepentamine (TEPA). Above the pentamines, i.e., the hexamines, heptamines, octamines and possibly nonamines, the cogenerically derived mixture does not appear to separate by distillation and can include other materials such as cyclic amines and particularly piperazines. There can also be present cyclic amines with side chains in which nitrogen atoms appear. See U.S. Patent 2,792,372, Dickinson, issued May 14, 1957, which describes the preparation of PEA's.

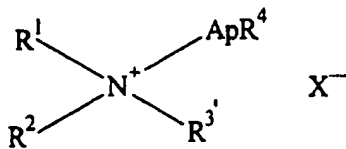
Preferred amine polymer backbones comprise R units that are C₂ alkylene (ethylene) units, also known as polyethylenimines (PEI's). Preferred PEI's have at least moderate branching, that is the ratio of m to n is less than 4:1, however PEI's having a ratio of m to n of about 2:1 are most preferred.

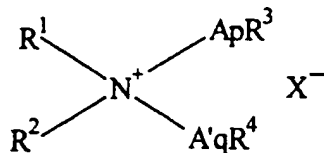
These polyamines can be prepared, for example, by polymerizing ethyleneimine in the presence of a catalyst such as carbon dioxide, sodium bisulfite, sulfuric acid, hydrogen peroxide, hydrochloric acid, acetic acid, etc. Specific methods for preparing these polyamine backbones are disclosed in U.S. Patent 2,182,306, Ulrich et al., issued December 5, 1939; U.S. Patent 3,033,746, Mayle et al., issued May 8, 1962; U.S. Patent 2,208,095, Esselmann et al., issued July 16, 1940; U.S. Patent 2,806,839, Crowther, issued September 17, 1957; and U.S. Patent 2,553,696, Wilson, issued May 21, 1951; all herein incorporated by reference.

The following formula depicts a preferred modified polyamine agent comprising a PEI backbone wherein all substitutable nitrogens are modified by replacement of hydrogen with a polyoxyalkyleneoxy unit, $-(\text{CH}_2\text{CH}_2\text{O})_{20}\text{H}$, having the formula:



Cationic Surfactants - The alkoxylated quaternary ammonium (AQA) surfactants useful in the present invention are of the general formula:





II

wherein R^1 is an alkyl or alkenyl moiety containing from about 8 to about 18 carbon atoms, preferably 10 to about 16 carbon atoms, most preferably from about 10 to about 14 carbon atoms; R^2 and R^3 are each independently alkyl groups containing from one to about three carbon atoms, preferably methyl; R^3 and R^4 can vary independently and are selected from hydrogen (preferred), methyl and ethyl, X^- is an anion such as chloride, bromide, methylsulfate, sulfate, or the like, to provide electrical neutrality; A is selected from C_1 - C_4 alkoxy, especially ethoxy (i.e., $-CH_2CH_2O-$), propoxy, butoxy and mixtures thereof; and for formula I, p is from 2 to about 30, preferably 2 to about 15, most preferably 2 to about 8; and for formula II, p is from 1 to about 30, preferably 1 to about 4 and q is from 1 to about 30, preferably 1 to about 4, and most preferably both p and q are 1.

The levels of the AQA surfactants used to prepare finished laundry detergent compositions can range from about 0.1% to about 5%, typically from about 0.45% to about 2.5%, by weight.

Amylase - Complete removal of the very hydrophobic "everyday" or "body" soils is difficult and low levels of residual soils often remain on the fabric after washing. These residues build up and act like an amorphous glue between the fibers, entrapping particulate dirt and leading to fabric yellowing. It has now further been discovered that detergent compositions containing a combination of the water-soluble polyamine agents herein and amylase enzymes delivers superior cleaning and whiteness performance vs. compositions containing either technology alone.

Such amylase enzymes include those described in WO95/26397 and in co-pending application by Novo Nordisk PCT/DK96/00056. These enzymes are incorporated into detergent compositions at a level from 0.00018% to 0.060% pure enzyme by weight of the total composition, more preferably from 0.00024% to 0.048% pure enzyme by weight of total weight composition.

Specific amylase enzymes for use in the detergent compositions of the present invention therefore include:

(a) α -amylases characterised by having a specific activity at least 25% higher than the specific activity of Termamyl® at a temperature range of 25°C to 55°C and at a pH value

in the range of 8 to 10, measured by the Phadebas® α -amylase activity assay. Such Phadebas® α -amylase activity assay is described at pages 9-10, WO95/26397.

(b) α -amylases according (a) comprising the amino sequence shown in the SEQ ID listings in the above cited reference. or an α -amylase being at least 80% homologous with the amino acid sequence shown in the SEQ ID listing.

(c) α -amylases according (a) comprising the following amino sequence in the N-terminal : His-His-Asn-Gly-Thr-Asn-Gly-Thr-Met-Met-Gln-Tyr-Phe-Glu-Trp-Tyr-Leu-Pro-Asn-Asp.

A polypeptide is considered to be X% homologous to the parent amylase if a comparison of the respective amino acid sequences, performed via algorithms, such as the one described by Lipman and Pearson in Science 227, 1985, p. 1435, reveals an identity of X%

(d) α -amylases according (a-c) wherein the α -amylase is obtainable from an alkalophilic Bacillus species; and in particular, from any of the strains NCIB 12289, NCIB 12512, NCIB 12513 and DSM 935.

In the context of the present invention, the term "obtainable from" is intended not only to indicate an amylase produced by a Bacillus strain but also an amylase encoded by a DNA sequence isolated from such a Bacillus strain and produced in a host organism transformed with said DNA sequence.

(e) α -amylase showing positive immunological cross-reactivity with antibodies raised against an α -amylase having an amino acid sequence corresponding respectively to those α -amylases in (a-d).

(f) Variants of the following parent α -amylases which (i) have one of the amino acid sequences shown in corresponding respectively to those α -amylases in (a-e), or (ii) displays at least 80% homology with one or more of said amino acid sequences, and/or displays immunological cross-reactivity with an antibody raised against an α -amylase having one of said amino acid sequences, and/or is encoded by a DNA sequence which hybridizes with the same probe as a DNA sequence encoding an α -amylase having one of said amino acid sequence; in which variants :

1. at least one amino acid residue of said parent α -amylase has been deleted; and/or
2. at least one amino acid residue of said parent α -amylase has been replaced by a different amino acid residue; and/or
3. at least one amino acid residue has been inserted relative to said parent α -amylase; said variant having an α -amylase activity and exhibiting at least one of the following properties relative to said parent α -amylase : increased thermostability, increased stability towards oxidation, reduced Ca^{2+} ion dependency, increased stability and/or α -

amylolytic activity at neutral to relatively high pH values, increased α -amylolytic activity at relatively high temperature and increase or decrease of the isoelectric point (pI) so as to better match the pI value for α -amylase variant to the pH of the medium.

The preferred amylases of this invention are those described by the following:

- (a) α -amylases characterised by having a specific activity at least 25% higher than the specific activity of Termamyl® at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by the Phadebas® α -amylase activity assay;
- (b) α -amylase showing positive immunological cross-reactivity with antibodies raised against an α -amylase having an amino acid sequence corresponding respectively to those α -amylases in (a); and
- (c) mixtures thereof.

Said variants are described in the patent application PCT/DK96/00056.

Other amylases suitable herein include, for example, α -amylases described in GB 1,296,839 to Novo; RAPIDASE®, International Bio-Synthetics, Inc. and TERMAMYL®, Novo. FUNGAMYL® from Novo is especially useful.

Engineering of enzymes for improved stability, e.g., oxidative stability, is known. See, for example J. Biological Chem., Vol. 260, No. 11, June 1985, pp. 6518-6521. Certain preferred embodiments of the present compositions can make use of amylases having improved stability in detergents, especially improved oxidative stability as measured against a reference-point of TERMAMYL® in commercial use in 1993. These preferred amylases herein share the characteristic of being "stability-enhanced" amylases, characterized, at a minimum, by a measurable improvement in one or more of: oxidative stability, e.g., to hydrogen peroxide/tetraacetylenediamine in buffered solution at pH 9-10; thermal stability, e.g., at common wash temperatures such as about 60°C; or alkaline stability, e.g., at a pH from about 8 to about 11, measured versus the above-identified reference-point amylase. Stability can be measured using any of the art-disclosed technical tests. See, for example, references disclosed in WO 9402597.

Stability-enhanced amylases can be obtained from Novo or from Genencor International. One class of highly preferred amylases herein have the commonality of being derived using site-directed mutagenesis from one or more of the *Bacillus* amylases, especially the *Bacillus* α -amylases, regardless of whether one, two or multiple amylase strains are the immediate precursors. Such preferred amylases include (a) an amylase according to the hereinbefore incorporated WO 9402597, Novo, Feb. 3, 1994, as further illustrated by a mutant in which substitution is made, using alanine or threonine, preferably threonine, of the methionine residue located in position 197 of the *B. licheniformis* alpha-amylase, known as TERMAMYL®, or the homologous position

variation of a similar parent amylase, such as *B. amyloliquefaciens*, *B. subtilis*, or *B. stearothermophilus*; (b) stability-enhanced amylases as described by Genencor International in a paper entitled "Oxidatively Resistant alpha-Amylases" presented at the 207th American Chemical Society National Meeting, March 13-17 1994, by C. Mitchinson. Therein it was noted that bleaches in detergents inactivate alpha-amylases but that improved oxidative stability amylases have been made by Genencor from *B. licheniformis* NCIB8061. Methionine (Met) was identified as the most likely residue to be modified. Met was substituted, one at a time, in positions 8, 15, 197, 256, 304, 366 and 438 leading to specific mutants, particularly important being M197L and M197T with the M197T variant being the most stable expressed variant. Stability was measured in CASCADE® and SUNLIGHT®; (c) particularly preferred amylases herein include amylase variants having additional modification in the immediate parent as described in WO 9510603 A and are available from the assignee, Novo, as DURAMYL®. Other particularly preferred oxidative stability enhanced amylase include those described in WO 9418314 to Genencor International and WO 9402597 to Novo. Any other oxidative stability-enhanced amylase can be used, for example as derived by site-directed mutagenesis from known chimeric, hybrid or simple mutant parent forms of available amylases. Other preferred enzyme modifications are accessible. See WO 9509909 A to Novo.

Other Enzymes - enzymes can be included in the present detergent compositions for a variety of purposes, including removal of protein-based, carbohydrate-based, or triglyceride-based stains from surfaces such as textiles or dishes, for the prevention of refugee dye transfer, for example in laundering, and for fabric restoration. Suitable other enzymes include proteases, lipases, peroxidases, and mixtures thereof of any suitable origin, such as vegetable, animal, bacterial, fungal and yeast origin. Preferred selections are influenced by factors such as pH-activity and/or stability optima, thermostability, and stability to active detergents, builders and the like. In this respect bacterial or fungal enzymes are preferred, such as bacterial amylases and proteases.

"Detergent enzyme", as used herein, means any enzyme having a cleaning, stain removing or otherwise beneficial effect in a laundry, hard surface cleaning or personal care detergent composition.

Enzymes are normally incorporated into detergent or detergent additive compositions at levels sufficient to provide a "cleaning-effective amount". The term "cleaning effective amount" refers to any amount capable of producing a cleaning, stain removal, soil removal, whitening, deodorizing, or freshness improving effect on substrates such as fabrics, dishware and the like. In practical terms for current

commercial preparations, typical amounts are up to about 5 mg by weight, more typically 0.01 mg to 3 mg, of active enzyme per gram of the detergent composition. Stated otherwise, the compositions herein will typically comprise from 0.001% to 5%, preferably 0.01%-1% by weight of a commercial enzyme preparation. Protease enzymes are usually present in such commercial preparations at levels sufficient to provide from 0.005 to 0.1 Anson units (AU) of activity per gram of composition. Higher active levels may be desirable in highly concentrated detergent formulations.

Peroxidase enzymes may be used in combination with oxygen sources, e.g., percarbonate, perborate, hydrogen peroxide, etc., for "solution bleaching" or prevention of transfer of dyes or pigments removed from substrates during the wash to other substrates present in the wash solution. Known peroxidases include horseradish peroxidase, ligninase, and haloperoxidases such as chloro- or bromo-peroxidase. Peroxidase-containing detergent compositions are disclosed in WO 89099813 A, October 19, 1989 to Novo and WO 8909813 A to Novo.

A range of enzyme materials and means for their incorporation into synthetic detergent compositions is also disclosed in WO 9307263 A and WO 9307260 A to Genencor International, WO 8908694 A to Novo, and U.S. 3,553,139, January 5, 1971 to McCarty et al. Enzymes are further disclosed in U.S. 4,101,457, Place et al, July 18, 1978, and in U.S. 4,507,219, Hughes, March 26, 1985. Enzyme materials useful for liquid detergent formulations, and their incorporation into such formulations, are disclosed in U.S. 4,261,868, Hora et al, April 14, 1981. Enzymes for use in detergents can be stabilized by various techniques. Enzyme stabilization techniques are disclosed and exemplified in U.S. 3,600,319, August 17, 1971, Gedge et al, EP 199,405 and EP 200,586, October 29, 1986, Venegas. Enzyme stabilization systems are also described, for example, in U.S. 3,519,570. A useful *Bacillus*, sp. AC13 giving proteases, xylanases and cellulases, is described in WO 9401532 A to Novo.

Proteases - Suitable examples of proteases are the subtilisins which are obtained from particular strains of *B. subtilis* and *B. licheniformis*. One suitable protease is obtained from a strain of *Bacillus*, having maximum activity throughout the pH range of 8-12, developed and sold as ESPERASE® by Novo Industries A/S of Denmark, hereinafter "Novo". The preparation of this enzyme and analogous enzymes is described in GB 1,243,784 to Novo. Other suitable proteases include ALCALASE® and SAVINASE® from Novo and MAXATASE® from International Bio-Synthetics, Inc., The Netherlands; as well as Protease A as disclosed in EP 130,756 A, January 9, 1985 and Protease B as disclosed in EP 303,761 A, April 28, 1987 and EP 130,756 A, January 9, 1985. See also a high pH protease from *Bacillus* sp. NCIMB 40338 described in WO

9318140 A to Novo. Enzymatic detergents comprising protease, one or more other enzymes, and a reversible protease inhibitor are described in WO 9203529 A to Novo. Other preferred proteases include those of WO 9510591 A to Procter & Gamble. When desired, a protease having decreased adsorption and increased hydrolysis is available as described in WO 9507791 to Procter & Gamble. A recombinant trypsin-like protease for detergents suitable herein is described in WO 9425583 to Novo.

In more detail, an especially preferred protease, referred to as "Protease D" is a carbonyl hydrolase variant having an amino acid sequence not found in nature, which is derived from a precursor carbonyl hydrolase by substituting a different amino acid for a plurality of amino acid residues at a position in said carbonyl hydrolase equivalent to position +76, preferably also in combination with one or more amino acid residue positions equivalent to those selected from the group consisting of +99, +101, +103, +104, +107, +123, +27, +105, +109, +126, +128, +135, +156, +166, +195, +197, +204, +206, +210, +216, +217, +218, +222, +260, +265, and/or +274 according to the numbering of *Bacillus amyloliquefaciens* subtilisin, as described in the patent applications of A. Baeck, et al, entitled "Protease-Containing Cleaning Compositions" having US Serial No. 08/322,676, and C. Ghosh, et al, "Bleaching Compositions Comprising Protease Enzymes" having US Serial No. 08/322,677, both filed October 13, 1994.

Preferred proteolytic enzymes are also modified bacterial serine proteases, such as those described in European Patent Application Serial Number 87 303,761.8, filed April 28, 1987 (particularly pages 17, 24 and 98), and which is called herein "Protease B", and in European Patent Application 199,404, Venegas, published October 29, 1986, which refers to a modified bacterial serine proteolytic enzyme which is called "Protease A" herein, Protease A as disclosed in EP 130,756 A, January 9, 1985 and Protease B as disclosed in EP 303,761 A, April 28, 1987 and EP 130,756 A, January 9, 1985.

Also preferred proteases are subtilisin enzymes, in particular BPN', that have been modified by mutating the various nucleotide sequences that code for the enzyme, thereby modifying the amino acid sequence of the enzyme. These modified subtilisin enzymes have decreased adsorption to and increased hydrolysis of an insoluble substrate as compared to the wild-type subtilisin. Also suitable are mutant genes encoding for such BPN' variants.

Preferred BPN' variants comprise wild-type amino acid sequence wherein the wild-type amino acid sequence at one or more of positions 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 218, 219 or 220 is substituted; wherein the BPN' variant has decreased adsorption to, and increased hydrolysis of, an

insoluble substrate as compared to the wild-type subtilisin BPN'. Preferably, the positions having a substituted amino acid are 199, 200, 201, 202, 205, 207, 208, 209, 210, 211, 212, or 215; more preferably, 200, 201, 202, 205 or 207.

Preferred protease enzymes for use according to the present invention also include the subtilisin 309 variants. These protease enzymes include several classes of subtilisin 309 variants.

A. Loop Region 6 Substitution Variants - These subtilisin 309 variants have a modified amino acid sequence of subtilisin 309 wild-type amino acid sequence, wherein the modified amino acid sequence comprises a substitution at one or more of positions 193, 194, 195, 196, 197, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213 or 214; whereby the subtilisin 309 variant has decreased adsorption to, and increased hydrolysis of, an insoluble substrate as compared to the wild-type subtilisin 309. Preferably these proteases have amino acids substituted at 193, 194, 195, 196, 199, 201, 202, 203, 204, 205, 206 or 209; more preferably 194, 195, 196, 199 or 200.

B. Multi-Loop Regions Substitution Variants - These subtilisin 309 variants may also be a modified amino acid sequence of subtilisin 309 wild-type amino acid sequence, wherein the modified amino acid sequence comprises a substitution at one or more positions in one or more of the first, second, third, fourth, or fifth loop regions; whereby the subtilisin 309 variant has decreased adsorption to, and increased hydrolysis of, an insoluble substrate as compared to the wild-type subtilisin 309.

C. Substitutions at positions other than the loop regions - In addition, one or more substitution of wild-type subtilisin 309 may be made at positions other than positions in the loop regions, for example, at position 74. If the additional substitution to the subtilisin 309 is mad at position 74 alone, the substitution is preferably with Asn, Asp, Glu, Gly, His, Lys, Phe or Pro, preferably His or Asp. However modifications can be made to one or more loop positions as well as position 74, for example residues 97, 99, 101, 102, 105 and 121.

Subtilisin BPN' variants and subtilisin 309 variants are further described in WO 95/29979, WO 95/30010 and WO 95/30011, all of which were published November 9, 1995, all of which are incorporated herein by reference.

Lipases - Suitable lipase enzymes for detergent usage include those produced by microorganisms of the *Pseudomonas* group, such as *Pseudomonas stutzeri* ATCC 19.154, as disclosed in GB 1,372,034. See also lipases in Japanese Patent Application 53,20487, laid open Feb. 24, 1978. Other suitable lipases include those which show a positive immunological cross-reaction with the antibody of the lipase, produced by the microorganism *Pseudomonas fluorescens* IAM 1057. This lipase is available from

Amano Pharmaceutical Co. Ltd., Nagoya, Japan, under the trade name Lipase P "Amano," hereinafter referred to as "Amano-P". Further suitable lipases are lipases such as M1 Lipase^R and Lipomax^R (Gist-Brocades). Other suitable commercial lipases include Amano-CES, lipases ex *Chromobacter viscosum*, e.g. *Chromobacter viscosum* var. *lipolyticum* NRRLB 3673 from Toyo Jozo Co., Tagata, Japan; *Chromobacter viscosum* lipases from U.S. Biochemical Corp., U.S.A. and Disoynt Co., The Netherlands, and lipases ex *Pseudomonas gladioli*. LIPOLASE[®] enzyme derived from *Humicola lanuginosa* and commercially available from Novo, see also EP 341,947, is a preferred lipase for use herein. Lipase variants stabilized against peroxidase enzymes are described in WO 9414951 A to Novo. See also WO 9205249 and RD 94359044.

Highly preferred lipases are the D96L lipolytic enzyme variant of the native lipase derived from *Humicola lanuginosa* as described in US Serial No. 08/341,826. (See also patent application WO 92/05249 viz. wherein the native lipase ex *Humicola lanuginosa* aspartic acid (D) residue at position 96 is changed to Leucine (L). According to this nomenclature said substitution of aspartic acid to Leucine in position 96 is shown as : D96L.) Preferably the *Humicola lanuginosa* strain DSM 4106 is used.

In spite of the large number of publications on lipase enzymes, only the lipase derived from *Humicola lanuginosa* and produced in *Aspergillus oryzae* as host has so far found widespread application as additive for fabric washing products. It is available from Novo Nordisk under the tradename Lipolase[™], as noted above. In order to optimize the stain removal performance of Lipolase, Novo Nordisk have made a number of variants. As described in WO 92/05249, the D96L variant of the native *Humicola lanuginosa* lipase improves the lard stain removal efficiency by a factor 4.4 over the wild-type lipase (enzymes compared in an amount ranging from 0.075 to 2.5 mg protein per liter). Research Disclosure No. 35944 published on March 10, 1994, by Novo Nordisk discloses that the lipase variant (D96L) may be added in an amount corresponding to 0.001-100- mg (5-500,000 LU/liter) lipase variant per liter of wash liquor.

Lipase enzyme is incorporated into the composition in accordance with the invention at a level of from 50 LU to 8500 LU per liter wash solution. Preferably the variant D96L is present at a level of from 100 LU to 7500 LU per liter of wash solution. More preferably at a level of from 150 LU to 5000 LU per liter of wash solution.

The lipases and/or cutinases are normally incorporated in the detergent composition at levels from 0.0001% to 2% of active enzyme by weight of the detergent composition.

Also suitable are cutinases [EC 3.1.1.50] which can be considered as a special kind of lipase, namely lipases which do not require interfacial activation. Addition of

cutinases to detergent compositions have been described in e.g. WO-A-88/09367 (Genencor).

Cellulase Enzymes - The laundry detergent compositions according to the present invention may further comprise at least 0.001% by weight, preferably at least about 0.01%, of a cellulase enzyme. However, an effective amount of cellulase enzyme is sufficient for use in the laundry detergent compositions described herein. The term "an effective amount" refers to any amount capable of producing a cleaning, stain removal, soil removal, whitening, deodorizing, or freshness improving effect on substrates such as fabrics, dishware and the like. The compositions herein will typically comprise from about 0.05% to about 2%, preferably from about 0.1% to about 1.5% by weight of a commercial enzyme preparation. The cellulase enzymes of the present invention are usually present in such commercial preparations at levels sufficient to provide from 0.005 to 0.1 Anson units (AU) of activity per gram of composition. Preferably, the optimum pH of the enzyme-containing composition is between about 7 and about 9.5.

U. S. Patent No. 4,435,307, Barbesgaard et al, issued March 6, 1984, discloses cellulase produced from *Humicola insolens*. Examples of other suitable cellulases include those produced by a strain of *Humicola insolens*, *Humicola grisea* var. *thermoidea*, and cellulases produced by a species of *Bacillus* sp. or *Aeromonas* sp. Other useful cellulases are those extracted from the hepatopancreas of the marine mollusc *Dolabella Auricula Solander*. Suitable cellulases are also disclosed in the following: GB 2,075,028 A (Novo Industri A/S); GB 2,095,275 A (Kao Soap Co., Ltd.); and Horikoshi et al, U.S. Patent No. 3,844,890 (Rikagaku Kenkyusho). In addition, suitable cellulases and methods for their preparation are described in PCT International Publication Number WO 91/17243, published November 14, 1991, by Novo Nordisk A/S.

Cellulases are known in the art and can be obtained from suppliers under the tradenames: Celluzyme®, Endolase®, and Carezyme®.

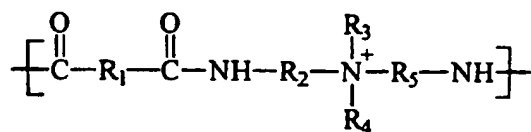
For industrial production of the cellulases herein it is preferred that recombinant DNA techniques be employed. However other techniques involving adjustments of fermentations or mutation of the microorganisms involved can be employed to ensure overproduction of the desired enzymatic activities. Such methods and techniques are known in the art and may readily be carried out by persons skilled in the art.

Polyamide-Polyamine Materials - Another optional but preferred component of the detergent compositions herein comprises one or more polyamide-polyamine materials fabric treatment agents. Such materials, especially when combined with the modified polyamine fabric appearance agents of this invention, have been found to impart a

number of appearance benefits to fabrics and textiles laundered in aqueous washing solutions formed from detergent compositions which contain such combinations. These fabric appearance benefits can include, for example, improved overall appearance of the laundered fabrics, reduction of the formation of pills and fuzz, protection against color fading, etc. The polyamine-polyamide polymers used in the compositions and methods herein can provide such fabric appearance benefits with acceptably little or no loss in cleaning performance provided by the laundry detergent compositions into which such materials are incorporated.

The polyamide-polyamines useful herein will generally comprise from about 0.1% to 8% by the weight of the composition. More preferably, such polyamide-polyamine materials will comprise from about 0.5% to 4% by weight of the compositions herein. Most preferably, these polyamide-polyamines will comprise from about 1% to 3% by weight of the composition.

The polyamide-polyamine materials used in this invention are those which have repeating, substituted amido-amine units which correspond to the general Structural Formula No. I as follows:



Structural Formula No. I

In Structural Formula No. I, R_1 , R_2 and R_5 are each independently C_{1-4} alkylene, C_{1-4} alkarylene or arylene. It is also possible to eliminate R_1 entirely so that the polyamide-polyamine is derived from oxalic acid.

Also in Structural Formula No. I, R_3 is H, epichlorohydrin, an azetidinium group, an epoxypropyl group or a dimethylaminohydroxypropyl group, and R_4 can be H, C_{1-4} alkyl, C_{1-4} alkaryl, or aryl. R_4 may also be any of the foregoing groups condensed with C_{1-4} alkylene oxide.

R_1 is preferably butylene, and R_2 and R_5 are preferably ethylene. R_3 is preferably epichlorohydrin. R_4 is preferably H.

The polyamide-polyamine materials useful herein can be prepared by reacting polyamines such as diethylenetriamine, triethylenetetraamine, tetraethylenepentamine or dipropylenetriamine with C_2 - C_{12} dicarboxylic acids such as oxalic, succinic, glutaric, adipic and diglycolic acids. Such materials may then be further derivatized by reaction with, for example, epichlorohydrin. Preparation of such materials is described in greater

detail in Keim, U.S. Patent 2,296,116, Issued February 23, 1960; Keim, U.S. Patent 2,296,154, Issued February 23, 1960 and Keim, U.S. Patent 3,332,901, Issued July 25, 1967. The disclosures of all three of these patents are incorporated herein by reference.

The polyamide-polyamine-epichlorohydrin fabric treatment agents preferred for use herein are commercially marketed by Hercules, Inc. under the tradename Kymene[®]. Especially useful are Kymene 557H[®] and Kymene 557LX[®] which are epichlorohydrin adducts of polyamide-polyamines which are the reaction products of diethylenetriamine and adipic acid. Other suitable materials are those marketed by Hercules under the tradenames Reten[®] and Delsette[®], and by Sandoz under the tradename Cartaretin[®]. These polyamide-polyamine materials are marketed in the form of aqueous suspensions of the polymeric material containing, for example, about 12.5% by weight of solids.

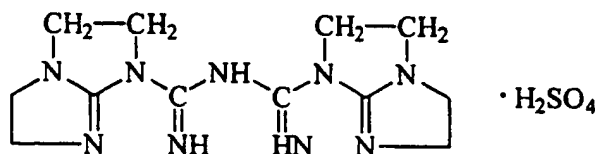
Dye Fixative Materials - optionally but preferred for use herein are selected dye fixative materials which do not form precipitates with anionic surfactant. Such non-precipitating dye fixative materials, particularly in combination with the modified polyamine fabric appearance agents of this invention, have been found to dye fixative benefits to fabrics and textiles laundered in aqueous washing solutions formed from detergent compositions which contain such dye fixatives. Additional benefits from the combination of these dye fixative materials and the modified polyamine fabric appearance agents of this invention can include, for example, improved overall appearance of the laundered fabrics and protection against color fading. The selected dye fixatives used in the compositions and methods herein can provide such fabric appearance benefits with acceptably little or no loss in cleaning performance provided by the laundry detergent compositions into which such materials are incorporated.

The selected dye fixatives useful herein may be in the form of unpolymerized materials, oligomers or polymers. Moreover, the preferred dye fixatives useful herein are cationic. The dye fixative component of the compositions herein will generally comprise from about 0.1% to 5% by the weight of the composition. More preferably, such dye fixative materials will comprise from about 0.5% to 4% by weight of the compositions, most preferably from about 1% to 3%. Such concentrations should be sufficient to provide from about 10 to 100 ppm of the dye fixative in the aqueous washing solutions formed from the laundry detergent compositions herein. More preferably from about 20 to 60 ppm of the dye fixative will be delivered to the aqueous washing solution, most preferably about 50 ppm.

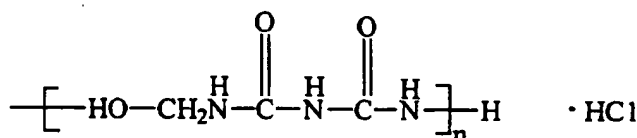
The non-precipitating dye fixatives useful herein include a number that are commercially marketed by CLARIANT Corporation under the Sandofix[®], Sandolec[®] and Polymer VRN[®] tradenames. These include, for example, Sandofix SWE[®],

Sandofix WA[®], Sandolec CT[®], Sandolec CS[®], Sandolec C1[®], Sandolec CF[®], Sandolec WA[®] and Polymer VRN[®]. Other suitable dye fixatives are marketed by Ciba-Geigy Corporation under the tradename Cassofix FRN-300[®] and by Hoechst Celanese Corporation under the tradename Tinofix EW[®].

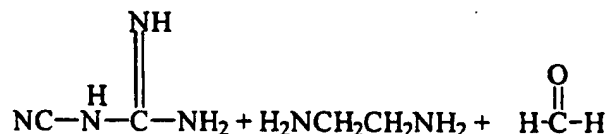
A preferred non-precipitating dye fixative is the Sandofix SWE[®] material which has the structure:



Another preferred non-precipitating dye fixative is the Sandofix WA[®] material which is polymer having the following structure:



Another preferred non-precipitating dye fixative is the Cassofix FRN-300[®] material which is also a polymer prepared from the following monomers:



The dye fixative materials used in this invention are generally all water-soluble materials. They can therefore be utilized for detergent composition preparation in the form of aqueous solutions of such dye fixatives if desired.

Alkyl alkoxyated sulfates and/or alkyl sulfates - The alkyl alkoxyated sulfate surfactants hereof are water soluble salts or acids of the formula $RO(A)_mSO_3M$ wherein R is an unsubstituted C₁₀-C₂₄ alkyl or hydroxyalkyl group having a C₁₀-C₂₄ alkyl component, preferably a C₁₂-C₁₈ alkyl or hydroxyalkyl, more preferably C₁₂-C₁₅ alkyl or hydroxyalkyl, A is an ethoxy or propoxy unit, m is greater than zero, typically between about 0.5 and about 6, more preferably between about 0.5 and about 3, and M is H or a cation which can be, for example, a metal cation (e.g., sodium, potassium, lithium, calcium, magnesium, etc.), ammonium or substituted-ammonium cation. Alkyl ethoxyated sulfates as well as alkyl propoxyated sulfates are contemplated herein.

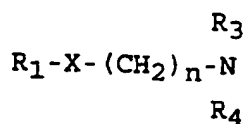
Specific examples of substituted ammonium cations include ethanol-, triethanol-, methyl-, dimethyl, trimethyl-ammonium cations and quaternary ammonium cations such as tetramethyl-ammonium and dimethyl piperidinium cations and those derived from alkylamines such as ethylamine, diethylamine, triethylamine, mixtures thereof, and the like. Exemplary surfactants are C₁₂-C₁₅ alkyl polyethoxylate (1.0) sulfate (C₁₂-C₁₅E(1.0)M), C₁₂-C₁₅ alkyl polyethoxylate (2.25) sulfate (C₁₂-C₁₅E(2.25)M), C₁₂-C₁₅ alkyl polyethoxylate (3.0) sulfate (C₁₂-C₁₅E(3.0)M), and C₁₂-C₁₅ alkyl polyethoxylate (4.0) sulfate (C₁₂-C₁₅E(4.0)M), wherein M is conveniently selected from sodium and potassium.

The alkyl sulfate surfactants hereof are water soluble salts or acids of the formula ROSO₃M wherein R preferably is a C₈-C₁₈ hydrocarbyl, preferably an alkyl or hydroxyalkyl having a C₁₀-C₁₈ alkyl component, more preferably a C₁₂-C₁₅ alkyl or hydroxyalkyl, and M is H or a cation, e.g., an alkali metal cation (e.g. sodium, potassium, lithium), or ammonium or substituted ammonium (e.g. methyl-, dimethyl-, and trimethyl ammonium cations and quaternary ammonium cations such as tetramethyl-ammonium and dimethyl piperidinium cations and quaternary ammonium cations derived from alkylamines such as ethylamine, diethylamine, triethylamine, and mixtures thereof, and the like).

Commercial alkyl alkoxyate sulfates comprise a mixture of compounds with varying degrees of alkoxylation. For example, C₁₂₋₁₅ polyoxyethylene (3) sulfate from Shell Chemical Company, Houston, TX, will contain molecules with from zero ethoxylates to five or more, for an average degree of ethoxylation = 3. The lower the average degree of ethoxylation of a given sample, the higher the level of alkyl sulfate (EO=0) which may be present in the mixture.

For purposes of this invention, the total amount of alkyl sulfate present in the detergent compositions herein include not only the alkyl sulfate added to the composition but also any alkyl sulfate which may be present in the alkyl alkoxyate sulfate surfactant mixture.

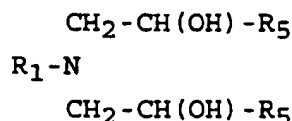
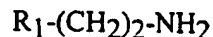
The amine - Suitable amine surfactants for use herein include amines according to the formula:



wherein R₁ is a C₆-C₁₂ alkyl group; n is from about 2 to about 4, X is a bridging group which is selected from NH, CONH, COO, or O or X can be absent; and R₃ and R₄ are

individually selected from H, C₁-C₄ alkyl, or (CH₂-CH₂-O(R₅)) wherein R₅ is H or methyl.

Preferred amines include the following:



wherein R₁ is a C₆-C₁₂ alkyl group and R₅ is H or CH₃.

In a highly preferred embodiment, the amine is described by the formula:



wherein R₁ is C₈-C₁₂ alkyl.

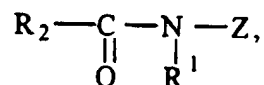
Particularly preferred amines include those selected from the group consisting of octyl amine, hexyl amine, decyl amine, dodecyl amine, C₈-C₁₂ bis(hydroxyethyl)amine, C₈-C₁₂ bis(hydroxyisopropyl)amine, and C₈-C₁₂ amido-propyl dimethyl amine, and mixtures.

Deterative Surfactants - Nonlimiting examples of anionic surfactants useful herein typically at levels of at least about 0.1%, preferably from about 0.1% to about 95%, more preferably from about 1% to about 55%, by weight, include the conventional C₁₁-C₁₈ alkyl benzene sulfonates ("LAS"), primary, branched-chain and random C₁₀-C₂₀ alkyl sulfates ("AS"), the C₁₀-C₁₈ secondary (2,3) alkyl sulfates of the formula CH₃(CH₂)_x(CHOSO₃⁻M⁺)CH₃ and CH₃(CH₂)_y(CHOSO₃⁻M⁺)CH₂CH₃ where x and (y + 1) are integers of at least about 7, preferably at least about 9, and M is a water-solubilizing cation, especially sodium, unsaturated sulfates such as oleyl sulfate, the C₁₀-C₁₈ alpha-sulfonated fatty acid esters, the C₁₀-C₁₈ sulfated alkyl polyglycosides, the C₁₀-C₁₈ alkyl alkoxy sulfates ("AEXS"; especially EO 1-7 ethoxy sulfates), and C₁₀-C₁₈ alkyl alkoxy carboxylates (especially the EO 1-5 ethoxycarboxylates). The C₁₂-C₁₈ betaines and sulfobetaines ("sultaines"), C₁₀-C₁₈ amine oxides, and the like, can also be included in the overall compositions. C₁₀-C₂₀ conventional soaps may also be used. If high sudsing is desired, the branched-chain C₁₀-C₁₆ soaps may be used. Other conventional useful surfactants are listed in standard texts.

Nonionic Surfactants - Nonlimiting examples of nonionic surfactants useful herein typically at levels of at least about 0.1%, preferably from about 0.1% to about 95%, more preferably from about 1% to about 55%, by weight, include the alkoxyated alcohols (AE's) and alkyl phenols, polyhydroxy fatty acid amides (PFAA's), alkyl polyglycosides (APG's), C₁₀-C₁₈ glycerol ethers, and the like.

More specifically, the condensation products of primary and secondary aliphatic alcohols with from about 1 to about 25 moles of ethylene oxide (AE) are suitable for use as the nonionic surfactant in the present invention. The alkyl chain of the aliphatic alcohol can either be straight or branched, primary or secondary, and generally contains from about 8 to about 22 carbon atoms. Preferred are the condensation products of alcohols having an alkyl group containing from about 8 to about 20 carbon atoms, more preferably from about 10 to about 18 carbon atoms, with from about 1 to about 10 moles, preferably 2 to 7, most preferably 2 to 5, of ethylene oxide per mole of alcohol. Examples of commercially available nonionic surfactants of this type include: Tergitol™ 15-S-9 (the condensation product of C₁₁-C₁₅ linear alcohol with 9 moles ethylene oxide) and Tergitol™ 24-L-6 NMW (the condensation product of C₁₂-C₁₄ primary alcohol with 6 moles ethylene oxide with a narrow molecular weight distribution), both marketed by Union Carbide Corporation; Neodol™ 45-9 (the condensation product of C₁₄-C₁₅ linear alcohol with 9 moles of ethylene oxide), Neodol™ 23-3 (the condensation product of C₁₂-C₁₃ linear alcohol with 3 moles of ethylene oxide), Neodol™ 45-7 (the condensation product of C₁₄-C₁₅ linear alcohol with 7 moles of ethylene oxide) and Neodol™ 45-5 (the condensation product of C₁₄-C₁₅ linear alcohol with 5 moles of ethylene oxide) marketed by Shell Chemical Company; Kyro™ EOB (the condensation product of C₁₃-C₁₅ alcohol with 9 moles ethylene oxide), marketed by The Procter & Gamble Company; and Genapol LA O3O or O5O (the condensation product of C₁₂-C₁₄ alcohol with 3 or 5 moles of ethylene oxide) marketed by Hoechst. The preferred range of HLB in these AE nonionic surfactants is from 8-11 and most preferred from 8-10. Condensates with propylene oxide and butylene oxides may also be used.

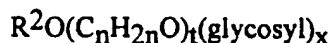
Another class of preferred nonionic surfactants for use herein are the polyhydroxy fatty acid amide surfactants of the formula.



wherein R¹ is H, or C₁₋₄ hydrocarbyl, 2-hydroxy ethyl, 2-hydroxy propyl or a mixture thereof, R² is C₅₋₃₁ hydrocarbyl, and Z is a polyhydroxyhydrocarbyl having a linear hydrocarbyl chain with at least 3 hydroxyls directly connected to the chain, or an

alkoxylated derivative thereof. Typical examples include the C₁₂-C₁₈ and C₁₂-C₁₄ N-methylglucamides. See U.S. 5,194,639 and 5,298,636. N-alkoxy polyhydroxy fatty acid amides can also be used; see U.S. 5,489,393.

Also useful as the nonionic surfactant in the present invention are the alkylpolysaccharides such as those disclosed in U.S. Patent 4,565,647, Llenado, issued January 21, 1986, having a hydrophobic group containing from about 6 to about 30 carbon atoms. The preferred alkylpolyglycosides have the formula



wherein R² is selected from the group consisting of alkyl, alkylphenyl, hydroxyalkyl, hydroxyalkylphenyl, and mixtures thereof in which the alkyl groups contain from about 10 to about 18, preferably from about 12 to about 14, carbon atoms; n is 2 or 3, preferably 2; t is from 0 to about 10, preferably 0; and x is from about 1.3 to about 10, preferably from about 1.3 to about 3, most preferably from about 1.3 to about 2.7.

Polyethylene, polypropylene, and polybutylene oxide condensates of alkyl phenols are also suitable for use as the nonionic surfactant of the surfactant systems of the present invention, with the polyethylene oxide condensates being preferred. Commercially available nonionic surfactants of this type include IgepalTM CO-630, marketed by the GAF Corporation; and TritonTM X-45, X-114, X-100 and X-102, all marketed by the Rohm & Haas Company. These surfactants are commonly referred to as alkylphenol alkoxylates (e.g., alkyl phenol ethoxylates).

The condensation products of ethylene oxide with a hydrophobic base formed by the condensation of propylene oxide with propylene glycol are also suitable for use as the additional nonionic surfactant in the present invention. The hydrophobic portion of these compounds will preferably have a molecular weight of from about 1500 to about 1800 and will exhibit water insolubility. Examples of compounds of this type include certain of the commercially-available PluronicTM surfactants, marketed by BASF.

Also suitable for use as the nonionic surfactant of the nonionic surfactant system of the present invention, are the condensation products of ethylene oxide with the product resulting from the reaction of propylene oxide and ethylenediamine. Examples of this type of nonionic surfactant include certain of the commercially available TetronicTM compounds, marketed by BASF.

Builders - Detergent builders can optionally but preferably be included in the compositions herein, for example to assist in controlling mineral, especially Ca and/or Mg, hardness in wash water or to assist in the removal of particulate soils from surfaces. Builder level can vary widely depending upon end use and physical form of the composition. Built detergents typically comprise at least about 1% builder. Liquid

formulations typically comprise about 5% to about 50%, more typically 5% to 35% of builder. Lower or higher levels of builders are not excluded. For example, certain detergent additive or high-surfactant formulations can be unbuilt.

A preferred builder for use herein are citrates, e.g., citric acid and soluble salts thereof. It is believed that the combination of polyamine fabric appearance agents of this invention in combination with citrate builder provides increase levels of cleaning. Thus, in one embodiment of the present invention, the detergent composition comprises from about 1% to about 10%, more preferably from about 2% to about 8%, still more preferably from about 4% to about 7%, by weight of citrate builder.

Suitable builders herein can be selected from the group consisting of phosphates and polyphosphates, especially the sodium salts; silicates including water-soluble and hydrous solid types and including those having chain-, layer-, or three-dimensional-structure as well as amorphous-solid or non-structured-liquid types; carbonates, bicarbonates, sesquicarbonates and carbonate minerals other than sodium carbonate or sesquicarbonate; aluminosilicates; organic mono-, di-, tri-, and tetracarboxylates especially water-soluble nonsurfactant carboxylates in acid, sodium, potassium or alkanolammonium salt form, as well as oligomeric or water-soluble low molecular weight polymer carboxylates including aliphatic and aromatic types; and phytic acid. These may be complemented by borates, e.g., for pH-buffering purposes, or by sulfates, especially sodium sulfate and any other fillers or carriers which may be important to the engineering of stable surfactant and/or builder-containing detergent compositions.

Builder mixtures, sometimes termed "builder systems" can be used and typically comprise two or more conventional builders, optionally complemented by chelants, pH-buffers or fillers, though these latter materials are generally accounted for separately when describing quantities of materials herein.

P-containing detergent builders often preferred where permitted by legislation include, but are not limited to, the alkali metal, ammonium and alkanolammonium salts of polyphosphates exemplified by the tripolyphosphates, pyrophosphates, glassy polymeric meta-phosphates; and phosphonates.

Suitable silicate builders include alkali metal silicates, particularly those liquids and solids having a $\text{SiO}_2:\text{Na}_2\text{O}$ ratio in the range 1.6:1 to 3.2:1, including, particularly for automatic dishwashing purposes, solid hydrous 2-ratio silicates marketed by PQ Corp. under the tradename BRITESIL®, e.g., BRITESIL H₂O; and layered silicates, e.g., those described in U.S. 4,664,839, May 12, 1987, H. P. Rieck. See preparative methods in German DE-A-3,417,649 and DE-A-3,742,043.

Also suitable for use herein are synthesized crystalline ion exchange materials or hydrates thereof as taught in U.S. 5,427,711, Sakaguchi et al, June 27, 1995.

Suitable carbonate builders include alkaline earth and alkali metal carbonates as disclosed in German Patent Application No. 2,321,001 published on November 15, 1973.

Aluminosilicate builders are especially useful in granular detergents, but can also be incorporated in liquids. Suitable for the present purposes are those having empirical formula: $[M_z(AlO_2)_z(SiO_2)_v] \cdot xH_2O$ wherein z and v are integers of at least 6, the molar ratio of z to v is in the range from 1.0 to 0.5, and x is an integer from 15 to 264.

Aluminosilicates can be crystalline or amorphous, naturally-occurring or synthetically derived. An aluminosilicate production method is in U.S. 3,985,669, Krummel, et al, October 12, 1976. Preferred synthetic crystalline aluminosilicate ion exchange materials are available as Zeolite A, Zeolite P (B), Zeolite X and, to whatever extent this differs from Zeolite P, the so-called Zeolite MAP.

Suitable organic detergent builders include polycarboxylate compounds, including water-soluble nonsurfactant dicarboxylates and tricarboxylates. More typically builder polycarboxylates have a plurality of carboxylate groups, preferably at least 3 carboxylates. Carboxylate builders can be formulated in acid, partially neutral, neutral or overbased form. When in salt form, alkali metals, such as sodium, potassium, and lithium, or alkanolammonium salts are preferred. Polycarboxylate builders include the ether polycarboxylates, such as oxydisuccinate, see Berg, U.S. 3,128,287, April 7, 1964, and Lamberti et al, U.S. 3,635,830, January 18, 1972; "TMS/TDS" builders of U.S. 4,663,071, Bush et al, May 5, 1987; and other ether carboxylates including cyclic and alicyclic compounds, such as those described in U.S. Patents 3,923,679; 3,835,163; 4,158,635; 4,120,874 and 4,102,903.

Other suitable builders are the ether hydroxypolycarboxylates, copolymers of maleic anhydride with ethylene or vinyl methyl ether; 1, 3, 5-trihydroxy benzene-2, 4, 6-trisulphonic acid; carboxymethyloxysuccinic acid; the various alkali metal, ammonium and substituted ammonium salts of polyacetic acids such as ethylenediamine tetraacetic acid and nitrilotriacetic acid; as well as mellitic acid, succinic acid, polymaleic acid, benzene 1,3,5-tricarboxylic acid, carboxymethyloxysuccinic acid, and soluble salts thereof.

Oxydisuccinates are also especially useful in such compositions and combinations.

Certain deterative surfactants or their short-chain homologs also have a builder action. For unambiguous formula accounting purposes, when they have surfactant capability, these materials are summed up as deterative surfactants. Preferred types for builder functionality are illustrated by: 3,3-dicarboxy-4-oxa-1,6-hexanedioates and the

related compounds disclosed in U.S. 4,566,984, Bush, January 28, 1986. Succinic acid builders include the C₅-C₂₀ alkyl and alkenyl succinic acids and salts thereof. Succinate builders also include: laurylsuccinate, myristylsuccinate, palmitylsuccinate, 2-dodecenylsuccinate (preferred), 2-pentadecenylsuccinate, and the like. Lauryl-succinates are described in European Patent Application 86200690.5/0,200,263, published November 5, 1986. Fatty acids, e.g., C₁₂-C₁₈ monocarboxylic acids, can also be incorporated into the compositions as surfactant/builder materials alone or in combination with the aforementioned builders, especially citrate and/or the succinate builders, to provide additional builder activity. Other suitable polycarboxylates are disclosed in U.S. 4,144,226, Crutchfield et al, March 13, 1979 and in U.S. 3,308,067, Diehl, March 7, 1967. See also Diehl, U.S. 3,723,322.

Other types of inorganic builder materials which can be used have the formula $(M_x)_i Ca_y (CO_3)_z$ wherein x and i are integers from 1 to 15, y is an integer from 1 to 10, z is an integer from 2 to 25, M_i are cations, at least one of which is a water-soluble, and the equation $\sum_i = 1.5(x_i \text{ multiplied by the valence of } M_i) + 2y = 2z$ is satisfied such that the formula has a neutral or "balanced" charge. These builders are referred to herein as "Mineral Builders".

Enzyme Stabilizing System - The enzyme-containing compositions herein may optionally also comprise from about 0.001% to about 10%, preferably from about 0.005% to about 8%, most preferably from about 0.01% to about 6%, by weight of an enzyme stabilizing system. The enzyme stabilizing system can be any stabilizing system which is compatible with the detergent enzyme. Such a system may be inherently provided by other formulation actives, or be added separately, e.g., by the formulator or by a manufacturer of detergent-ready enzymes. Such stabilizing systems can, for example, comprise calcium ion, boric acid, propylene glycol, short chain carboxylic acids, boronic acids, and mixtures thereof, and are designed to address different stabilization problems depending on the type and physical form of the detergent composition.

Another stabilizing approach is by use of borate species. See Severson, U.S. 4,537,706.

Stabilizing systems of certain cleaning compositions may further comprise from 0 to about 10%, preferably from about 0.01% to about 6% by weight, of chlorine scavengers, added to prevent chlorine bleach species present in many water supplies from attacking and inactivating the enzymes, especially under alkaline conditions. Antioxidants such as carbamate, ascorbate, etc., organic amines such as ethylenediaminetetracetic acid (EDTA) or alkali metal salt thereof, monoethanolamine

(MEA), and mixtures thereof can likewise be used. Likewise, special enzyme inhibition systems can be incorporated such that different enzymes have maximum compatibility. Other conventional scavengers such as bisulfate, nitrate, chloride, sources of hydrogen peroxide such as sodium perborate tetrahydrate, sodium perborate monohydrate and sodium percarbonate, as well as phosphate, condensed phosphate, acetate, benzoate, citrate, formate, lactate, malate, tartrate, salicylate, etc., and mixtures thereof can be used if desired.

Polymeric Soil Release Agent - Known polymeric soil release agents, hereinafter "SRA" or "SRA's", can optionally be employed in the present detergent compositions. If utilized, SRA's will generally comprise from 0.01% to 10.0%, typically from 0.1% to 5%, preferably from 0.2% to 3.0% by weight, of the composition.

SRA's can include a variety of charged, e.g., anionic or even cationic (see U.S. 4,956,447), as well as noncharged monomer units and structures may be linear, branched or even star-shaped. They may include capping moieties which are especially effective in controlling molecular weight or altering the physical or surface-active properties. Structures and charge distributions may be tailored for application to different fiber or textile types and for varied detergent or detergent additive products.

Suitable SRA's include a sulfonated product of a substantially linear ester oligomer comprised of an oligomeric ester backbone of terephthaloyl and oxyalkyleneoxy repeat units, for example as described in U.S. 4,968,451, November 6, 1990 to J.J. Scheibel and E.P. Gosselink. See U.S. 4,711,730, December 8, 1987 to Gosselink et al, for examples of those produced by transesterification/ oligomerization of poly(ethyleneglycol) methyl ether, DMT, PG and poly(ethyleneglycol) ("PEG"). Partly- and fully- anionic-end-capped oligomeric esters of U.S. 4,721,580, January 26, 1988 to Gosselink, such as oligomers from ethylene glycol ("EG"), PG, DMT and Na-3,6-dioxa-8-hydroxyoctanesulfonate; the nonionic-capped block polyester oligomeric compounds of U.S. 4,702,857, October 27, 1987 to Gosselink, for example produced from DMT, Me-capped PEG and EG and/or PG, or a combination of DMT, EG and/or PG, Me-capped PEG and Na-dimethyl-5-sulfoisophthalate; and the anionic, especially sulfoaroyl, end-capped terephthalate esters of U.S. 4,877,896, October 31, 1989 to Maldonado, Gosselink et al.

SRA's also include simple copolymeric blocks of ethylene terephthalate or propylene terephthalate with polyethylene oxide or polypropylene oxide terephthalate, see U.S. 3,959,230 to Hays, May 25, 1976 and U.S. 3,893,929 to Basadur, July 8, 1975; cellulosic derivatives such as the hydroxyether cellulosic polymers available as METHOCEL from Dow; and the C₁-C₄ alkylcelluloses and C₄ hydroxyalkyl celluloses;

see U.S. 4,000,093, December 28, 1976 to Nicol, et al. Suitable SRA's characterised by poly(vinyl ester) hydrophobe segments include graft copolymers of poly(vinyl ester), e.g., C₁-C₆ vinyl esters, preferably poly(vinyl acetate), grafted onto polyalkylene oxide backbones. See European Patent Application 0 219 048, published April 22, 1987 by Kud, et al. Commercially available examples include SOKALAN SRA's such as SOKALAN HP-22, available from BASF, Germany. Other SRA's are polyesters with repeat units containing 10-15% by weight of ethylene terephthalate together with 90-80% by weight of polyoxyethylene terephthalate, derived from a polyoxyethylene glycol of average molecular weight 300-5,000. Commercial examples include ZELCON 5126 from Dupont and MILEASE T from ICI.

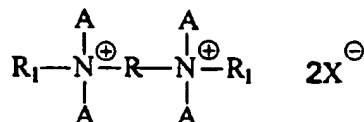
U.S. 5,415,807, Gosselink, Pan, Kellett and Hall, issued May 16, 1995. Suitable monomers for the above SRA include Na 2-(2-hydroxyethoxy)-ethanesulfonate, DMT, Na- dimethyl 5-sulfoisophthalate, EG and PG.

Additional classes of SRA's include (I) nonionic terephthalates using diisocyanate coupling agents to link up polymeric ester structures, see U.S. 4,201,824, Violland et al. and U.S. 4,240,918 Lagasse et al; (II) SRA's with carboxylate terminal groups made by adding trimellitic anhydride to known SRA's to convert terminal hydroxyl groups to trimellitate esters. With a proper selection of catalyst, the trimellitic anhydride forms linkages to the terminals of the polymer through an ester of the isolated carboxylic acid of trimellitic anhydride rather than by opening of the anhydride linkage. Either nonionic or anionic SRA's may be used as starting materials as long as they have hydroxyl terminal groups which may be esterified. See U.S. 4,525,524 Tung et al.; (III) anionic terephthalate-based SRA's of the urethane-linked variety, see U.S. 4,201,824, Violland et al; (IV) poly(vinyl caprolactam) and related co-polymers with monomers such as vinyl pyrrolidone and/or dimethylaminoethyl methacrylate, including both nonionic and cationic polymers, see U.S. 4,579,681, Ruppert et al.; (V) graft copolymers, in addition to the SOKALAN types from BASF made, by grafting acrylic monomers on to sulfonated polyesters; these SRA's assertedly have soil release and anti-redeposition activity similar to known cellulose ethers: see EP 279,134 A, 1988, to Rhone-Poulenc Chemie; (VI) grafts of vinyl monomers such as acrylic acid and vinyl acetate on to proteins such as caseins, see EP 457,205 A to BASF (1991); (VII) polyester-polyamide SRA's prepared by condensing adipic acid, caprolactam, and polyethylene glycol, especially for treating polyamide fabrics, see Bevan et al, DE 2,335,044 to Unilever N. V., 1974. Other useful SRA's are described in U.S. Patents 4,240,918, 4,787,989, 4,525,524 and 4,877,896.

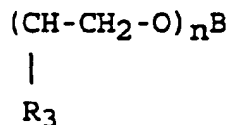
Clay Soil Removal/Anti-redeposition Agents - The compositions of the present invention can also optionally contain water-soluble ethoxylated amines having clay soil removal and antiredeposition properties. Liquid detergent compositions which contain these compounds typically contain from about 0.01% to about 5% by weight of the water-soluble ethoxylates amines.

The most preferred soil release and anti-redeposition agent is ethoxylated tetraethylene-pentamine. Exemplary ethoxylated amines are further described in U.S. Patent 4,597,898, VanderMeer, issued July 1, 1986. Another group of preferred clay soil removal-antiredeposition agents are the cationic compounds disclosed in European Patent Application 111,965, Oh and Gosselink, published June 27, 1984. Other clay soil removal/antiredeposition agents which can be used include the ethoxylated amine polymers disclosed in European Patent Application 111,984, Gosselink, published June 27, 1984; the zwitterionic polymers disclosed in European Patent Application 112,592, Gosselink, published July 4, 1984; and the amine oxides disclosed in U.S. Patent 4,548,744, Connor, issued October 22, 1985. Other clay soil removal and/or anti redeposition agents known in the art can also be utilized in the compositions herein. See U.S. Patent 4,891,160, VanderMeer, issued January 2, 1990 and WO 95/32272, published November 30, 1995. Another type of preferred antiredeposition agent includes the carboxy methyl cellulose (CMC) materials. These materials are well known in the art.

Optionally, but preferred antiredeposition agents useful for this invention are alkoxylated quaternary diamines of the general formula:

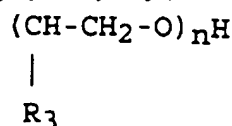


where R is selected from linear or branched C₂-C₁₂ alkylene, C₃-C₁₂ hydroxyalkylene, C₄-C₁₂ dihydroxyalkylene, C₈-C₁₂ dialkylarylene, [(CH₂CH₂O)_qCH₂CH₂]- and -CH₂CH(OH)CH₂O-(CH₂CH₂O)_qCH₂CH(OH)CH₂]- where q is from about 1 to about 100. Each R₁ is independently selected from C₁-C₄ alkyl, C₇-C₁₂ alkylaryl, or A. A is of the formula:



where R₃ is selected from H or C₁-C₃ alkyl, n is from about 5 to about 100, and B is selected from H, C₁-C₄ alkyl, acetyl, or benzoyl; X is a water soluble anion.

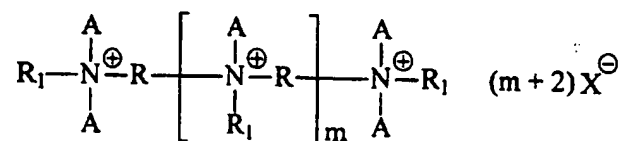
In preferred embodiments, R is selected from C₄ to C₈ alkylene, R₁ is selected from C₁-C₂ alkyl or C₂-C₃ hydroxyalkyl, and A is:



where R₃ is selected from H or methyl, and n is from about 10 to about 50.

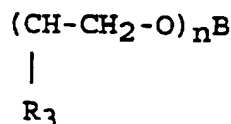
In another preferred embodiment R is linear or branched C₆, R₁ is methyl, R₃ is H, and n is from about 20 to about 50.

Another optional but preferred antideposition agent is alkoxyated quaternary polyamines of the general formula:



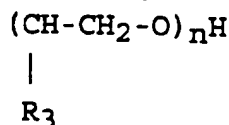
where R is selected from linear or branched C₂-C₁₂ alkylene, C₃-C₁₂ hydroxyalkylene, C₄-C₁₂ dihydroxyalkylene, C₈-C₁₂ dialkylarylene, [(CH₂CH₂O)_qCH₂CH₂]- and -CH₂CH(OH)CH₂O-(CH₂CH₂O)_qCH₂CH(OH)CH₂]- where q is from about 1 to about 100. If present, Each R₁ is independently selected from C₁-C₄ alkyl, C₇-C₁₂ alkylaryl, or A. R₁ may be absent on some nitrogens; however, at least three nitrogens must be quaternized.

A is of the formula:



where R₃ is selected from H or C₁-C₃ alkyl, n is from about 5 to about 100, and B is selected from H, C₁-C₄ alkyl, acetyl, or benzoyl; m is from about 1 to about 4, and X is a water soluble anion.

In preferred embodiments, R is selected from C₄ to C₈ alkylene, R₁ is selected from C₁-C₂ alkyl or C₂-C₃ hydroxyalkyl, and A is:



where R₃ is selected from H or methyl, and n is from about 10 to about 50; and m is 1.

In another preferred embodiment R is linear or branched C₆, R₁ is methyl, R₃ is H, and n is from about 20 to about 50, and m is 1.

These antiredeposition agents can be synthesized following the methods outline in US. Patent No. 4,664,848, or other ways known to those skilled in the art.

The levels of the redeposition agents used to prepare finished laundry detergent compositions can range from about 0.1% to about 10%, typically from about 0.4% to about 5%, by weight.

Polymeric Dispersing Agents - Polymeric dispersing agents can advantageously be utilized at levels from about 0.1% to about 7%, by weight, in the compositions herein, especially in the presence of zeolite and/or layered silicate builders. Suitable polymeric dispersing agents include polymeric polycarboxylates and polyethylene glycols, although others known in the art can also be used. It is believed, though it is not intended to be limited by theory, that polymeric dispersing agents enhance overall detergent builder performance, when used in combination with other builders (including lower molecular weight polycarboxylates) by crystal growth inhibition, particulate soil release peptization, and anti-redeposition.

Polymeric polycarboxylate materials can be prepared by polymerizing or copolymerizing suitable unsaturated monomers, preferably in their acid form. Unsaturated monomeric acids that can be polymerized to form suitable polymeric polycarboxylates include acrylic acid, maleic acid (or maleic anhydride), fumaric acid, itaconic acid, aconitic acid, mesaconic acid, citraconic acid and methylenemalononic acid. The presence in the polymeric polycarboxylates herein or monomeric segments, containing no carboxylate radicals such as vinylmethyl ether, styrene, ethylene, etc. is suitable provided that such segments do not constitute more than about 40% by weight.

Particularly suitable polymeric polycarboxylates can be derived from acrylic acid. Such acrylic acid-based polymers which are useful herein are the water-soluble salts of polymerized acrylic acid. The average molecular weight of such polymers in the acid form preferably ranges from about 2,000 to 10,000, more preferably from about 4,000 to 7,000 and most preferably from about 4,000 to 5,000. Water-soluble salts of such acrylic acid polymers can include, for example, the alkali metal, ammonium and substituted ammonium salts. Soluble polymers of this type are known materials. Use of polyacrylates of this type in detergent compositions has been disclosed, for example, in Diehl, U.S. Patent 3,308,067, issued march 7, 1967.

Acrylic/maleic-based copolymers may also be used as a preferred component of the dispersing/anti-redeposition agent. Such materials include the water-soluble salts of copolymers of acrylic acid and maleic acid. The average molecular weight of such copolymers in the acid form preferably ranges from about 2,000 to 100,000, more preferably from about 5,000 to 75,000, most preferably from about 7,000 to 65,000. The

ratio of acrylate to maleate segments in such copolymers will generally range from about 30:1 to about 1:1, more preferably from about 10:1 to 2:1. Water-soluble salts of such acrylic acid/maleic acid copolymers can include, for example, the alkali metal, ammonium and substituted ammonium salts. Soluble acrylate/maleate copolymers of this type are known materials which are described in European Patent Application No. 66915, published December 15, 1982, as well as in EP 193,360, published September 3, 1986, which also describes such polymers comprising hydroxypropylacrylate. Still other useful dispersing agents include the maleic/acrylic/vinyl alcohol terpolymers. Such materials are also disclosed in EP 193,360, including, for example, the 45/45/10 terpolymer of acrylic/maleic/vinyl alcohol.

Another polymeric material which can be included is polyethylene glycol (PEG). PEG can exhibit dispersing agent performance as well as act as a clay soil removal-antiredeposition agent. Typical molecular weight ranges for these purposes range from about 500 to about 100,000, preferably from about 1,000 to about 50,000, more preferably from about 1,500 to about 10,000.

Polyaspartate and polyglutamate dispersing agents may also be used, especially in conjunction with zeolite builders. Dispersing agents such as polyaspartate preferably have a molecular weight (avg.) of about 10,000.

Brightener - Any optical brighteners or other brightening or whitening agents known in the art can be incorporated at levels typically from about 0.01% to about 1.2%, by weight, into the detergent compositions herein. Commercial optical brighteners which may be useful in the present invention can be classified into subgroups, which include, but are not necessarily limited to, derivatives of stilbene, pyrazoline, coumarin, carboxylic acid, methinecyanines, dibenzothiophene-5,5-dioxide, azoles, 5- and 6-membered-ring heterocycles, and other miscellaneous agents. Examples of such brighteners are disclosed in "The Production and Application of Fluorescent Brightening Agents", M. Zahradnik, Published by John Wiley & Sons, New York (1982).

Specific examples of optical brighteners which are useful in the present compositions are those identified in U.S. Patent 4,790,856, issued to Wixon on December 13, 1988. These brighteners include the PHORWHITE series of brighteners from Verona. Other brighteners disclosed in this reference include: Tinopal UNPA, Tinopal CBS and Tinopal 5BM; available from Ciba-Geigy; Artic White CC and Artic White CWD, the 2-(4-styryl-phenyl)-2H-naphtho[1,2-d]triazoles; 4,4'-bis-(1,2,3-triazol-2-yl)-stilbenes; 4,4'-bis(styryl)bisphenyls; and the aminocoumarins. See also U.S. Patent 3,646,015, issued February 29, 1972 to Hamilton.

Dye Transfer Inhibiting Agents - The compositions of the present invention may also include one or more materials effective for inhibiting the transfer of dyes from one fabric to another during the cleaning process. Generally, such dye transfer inhibiting agents include polyvinyl pyrrolidone polymers, polyamine N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, manganese phthalocyanine, peroxidases, and mixtures thereof. If used, these agents typically comprise from about 0.01% to about 10% by weight of the composition, preferably from about 0.01% to about 5%, and more preferably from about 0.05% to about 2%.

More specifically, the polyamine N-oxide polymers preferred for use herein contain units having the following structural formula: $R-A_x-P$; wherein P is a polymerizable unit to which an N-O group can be attached or the N-O group can form part of the polymerizable unit or the N-O group can be attached to both units; A is one of the following structures: $-NC(O)-$, $-C(O)O-$, $-S-$, $-O-$, $-N=$; x is 0 or 1; and R is aliphatic, ethoxylated aliphatics, aromatics, heterocyclic or alicyclic groups or any combination thereof to which the nitrogen of the N-O group can be attached or the N-O group is part of these groups. Preferred polyamine N-oxides are those wherein R is a heterocyclic group such as pyridine, pyrrole, imidazole, pyrrolidine, piperidine and derivatives thereof.

The N-O group can be represented by the following general structures:

The most preferred polyamine N-oxide useful in the detergent compositions herein is poly(4-vinylpyridine-N-oxide) which as an average molecular weight of about 50,000 and an amine to amine N-oxide ratio of about 1:4.

Copolymers of N-vinylpyrrolidone and N-vinylimidazole polymers (referred to as a class as "PVPVI") are also preferred for use herein. Preferably the PVPVI has an average molecular weight range from 5,000 to 1,000,000, more preferably from 5,000 to 200,000, and most preferably from 10,000 to 20,000. (The average molecular weight range is determined by light scattering as described in Barth, et al., Chemical Analysis, Vol 113. "Modern Methods of Polymer Characterization", the disclosures of which are incorporated herein by reference.) The PVPVI copolymers typically have a molar ratio of N-vinylimidazole to N-vinylpyrrolidone from 1:1 to 0.2:1, more preferably from 0.8:1 to 0.3:1, most preferably from 0.6:1 to 0.4:1. These copolymers can be either linear or branched.

The present invention compositions also may employ a poly-vinyl-pyrrolidone ("PVP") having an average molecular weight of from about 5,000 to about 400,000, preferably from about 5,000 to about 200,000, and more preferably from about 5,000 to about 50,000. PVP's are known to persons skilled in the detergent field; see, for example,

EP-A-262,897 and EP-A-256,696, incorporated herein by reference. Compositions containing PVP can also contain polyethylene glycol ("PEG") having an average molecular weight from about 500 to about 100,000, preferably from about 1,000 to about 10,000. Preferably, the ratio of PEG to PVP on a ppm basis delivered in wash solutions is from about 2:1 to about 50:1, and more preferably from about 3:1 to about 10:1.

The detergent compositions herein may also optionally contain from about 0.005% to 5% by weight of certain types of hydrophilic optical brighteners which also provide a dye transfer inhibition action. If used, the compositions herein will preferably comprise from about 0.01% to 1% by weight of such optical brighteners.

When in the above formula, R_1 is anilino, R_2 is N-2-bis-hydroxyethyl and M is a cation such as sodium, the brightener is 4,4',-bis[(4-anilino-6-(N-2-bis-hydroxyethyl)-s-triazine-2-yl)amino]-2,2'-stilbenedisulfonic acid and disodium salt. This particular brightener species is commercially marketed under the tradename Tinopal-UNPA-GX by Ciba-Geigy Corporation. Tinopal-UNPA-GX is the preferred hydrophilic optical brightener useful in the detergent compositions herein.

When in the above formula, R_1 is anilino, R_2 is N-2-hydroxyethyl-N-2-methylamino and M is a cation such as sodium, the brightener is 4,4',-bis[(4-anilino-6-(N-2-hydroxyethyl-N-methylamino)-s-triazine-2-yl)amino]-2,2'-stilbenedisulfonic acid disodium salt. This particular brightener species is commercially marketed under the tradename Tinopal 5BM-GX by Ciba-Geigy Corporation.

When in the above formula, R_1 is anilino, R_2 is morpholino and M is a cation such as sodium, the brightener is 4,4',-bis[(4-anilino-6-morpholino-s-triazine-2-yl)amino]-2,2'-stilbenedisulfonic acid, sodium salt. This particular brightener species is commercially marketed under the tradename Tinopal AMS-GX by Ciba Geigy Corporation.

Chelating Agents - The detergent compositions herein may also optionally contain one or more iron and/or manganese chelating agents. Such chelating agents can be selected from the group consisting of amino carboxylates, amino phosphonates, polyfunctionally-substituted aromatic chelating agents and mixtures therein, all as hereinafter defined. Without intending to be bound by theory, it is believed that the benefit of these materials is due in part to their exceptional ability to remove iron and manganese ions from washing solutions by formation of soluble chelates.

Amino carboxylates useful as optional chelating agents include ethylenediaminetetracetates, N-hydroxyethylethylenediaminetriacetates, nitrilotriacetates, ethylenediamine tetrapropionates, triethylenetetraaminehexacetates, diethylenetriaminepentaacetates, and ethanoldiglycines, alkali metal, ammonium, and substituted ammonium salts therein and mixtures therein.

Amino phosphonates are also suitable for use as chelating agents in the compositions of the invention when at least low levels of total phosphorus are permitted in detergent compositions, and include ethylenediaminetetrakis (methylenephosphonates) as DEQUEST. Preferred, these amino phosphonates do not contain alkyl or alkenyl groups with more than about 6 carbon atoms.

Polyfunctionally-substituted aromatic chelating agents are also useful in the compositions herein. See U.S. Patent 3,812,044, issued May 21, 1974, to Connor et al. Preferred compounds of this type in acid form are dihydroxydisulfobenzenes such as 1,2-dihydroxy-3,5-disulfobenzene.

A preferred biodegradable chelator for use herein is ethylenediamine disuccinate ("EDDS"), especially the [S,S] isomer as described in U.S. Patent 4,704,233, November 3, 1987, to Hartman and Perkins.

The compositions herein may also contain water-soluble methyl glycine diacetic acid (MGDA) salts (or acid form) as a chelant or co-builder useful with, for example, insoluble builders such as zeolites, layered silicates and the like.

If utilized, these chelating agents will generally comprise from about 0.1% to about 15% by weight of the detergent compositions herein. More preferably, if utilized, the chelating agents will comprise from about 0.1% to about 3.0% by weight of such compositions.

Suds Suppressors - Compounds for reducing or suppressing the formation of suds can be incorporated into the compositions of the present invention. Suds suppression can be of particular importance in the so-called "high concentration cleaning process" as described in U.S. 4,489,455 and 4,489,574 and in front-loading European-style washing machines.

A wide variety of materials may be used as suds suppressors, and suds suppressors are well known to those skilled in the art. See, for example, Kirk Othmer Encyclopedia of Chemical Technology, Third Edition, Volume 7, pages 430-447 (John Wiley & Sons, Inc., 1979). One category of suds suppressor of particular interest encompasses monocarboxylic fatty acid and soluble salts therein. See U.S. Patent 2,954,347, issued September 27, 1960 to Wayne St. John. The monocarboxylic fatty acids and salts thereof used as suds suppressor typically have hydrocarbyl chains of 10 to about 24 carbon atoms, preferably 12 to 18 carbon atoms. Suitable salts include the alkali metal salts such as sodium, potassium, and lithium salts, and ammonium and alkanolammonium salts.

The detergent compositions herein may also contain non-surfactant suds suppressors. These include, for example: high molecular weight hydrocarbons such as

paraffin, fatty acid esters (e.g., fatty acid triglycerides), fatty acid esters of monovalent alcohols, aliphatic C₁₈-C₄₀ ketones (e.g., stearone), etc. Other suds inhibitors include N-alkylated amino triazines such as tri- to hexa-alkylmelamines or di- to tetra-alkyldiamine chlortriazines formed as products of cyanuric chloride with two or three moles of a primary or secondary amine containing 1 to 24 carbon atoms, propylene oxide, and monostearyl phosphates such as monostearyl alcohol phosphate ester and monostearyl di-alkali metal (e.g., K, Na, and Li) phosphates and phosphate esters. The hydrocarbons such as paraffin and haloparaffin can be utilized in liquid form. Hydrocarbon suds suppressors are described, for example, in U.S. Patent 4,265,779, issued May 5, 1981 to Gandolfo et al.

Another preferred category of non-surfactant suds suppressors comprises silicone suds suppressors. This category includes the use of polyorganosiloxane oils, such as polydimethylsiloxane, dispersions or emulsions of polyorganosiloxane oils or resins, and combinations of polyorganosiloxane with silica particles wherein the polyorganosiloxane is chemisorbed or fused onto the silica. Silicone suds suppressors are well known in the art and are, for example, disclosed in U.S. Patent 4,265,779, issued May 5, 1981 to Gandolfo et al and European Patent Application No. 89307851.9, published February 7, 1990, by Starch, M. S.

Other silicone suds suppressors are disclosed in U.S. Patent 3,455,839 which relates to compositions and processes for defoaming aqueous solutions by incorporating therein small amounts of polydimethylsiloxane fluids.

Mixtures of silicone and silanated silica are described, for instance, in German Patent Application DOS 2,124,526. Silicone defoamers and suds controlling agents in granular detergent compositions are disclosed in U.S. Patent 3,933,672, Bartolotta et al, and in U.S. Patent 4,652,392, Baginski et al, issued March 24, 1987.

Other suds suppressors useful herein comprise the secondary alcohols (e.g., 2-alkyl alkanols) and mixtures of such alcohols with silicone oils, such as the silicones disclosed in U.S. 4,798,679, 4,075,118 and EP 150,872. The secondary alcohols include the C₆-C₁₆ alkyl alcohols having a C₁-C₁₆ chain. A preferred alcohol is 2-butyl octanol, which is available from Condea under the trademark ISOFOL 12. Mixtures of secondary alcohols are available under the trademark ISALCHEM 123 from Enichem. Mixed suds suppressors typically comprise mixtures of alcohol + silicone at a weight ratio of 1:5 to 5:1.

Alkoxyated Polycarboxylates - Alkoxyated polycarboxylates such as those prepared from polyacrylates are useful herein to provide additional grease removal performance. Such materials are described in WO 91/08281 and PCT 90/01815 at p. 4 et

seq., incorporated herein by reference. Chemically, these materials comprise polyacrylates having one ethoxy side-chain per every 7-8 acrylate units. The side-chains are of the formula $-(CH_2CH_2O)_m(CH_2)_nCH_3$ wherein m is 2-3 and n is 6-12. The side-chains are ester-linked to the polyacrylate "backbone" to provide a "comb" polymer type structure. The molecular weight can vary, but is typically in the range of about 2000 to about 50,000. Such alkoxyated polycarboxylates can comprise from about 0.05% to about 10%, by weight, of the compositions herein.

Fabric Softeners - Various through-the-wash fabric softeners, especially the impalpable smectite clays of U.S. Patent 4,062,647, Storm and Nirschl, issued December 13, 1977, as well as other softener clays known in the art, can optionally be used typically at levels of from about 0.5% to about 10% by weight in the present compositions to provide fabric softener benefits concurrently with fabric cleaning. Clay softeners can be used in combination with amine and cationic softeners as disclosed, for example, in U.S. Patent 4,375,416, Crisp et al, March 1, 1983 and U.S. Patent 4,291,071, Harris et al, issued September 22, 1981.

Perfumes - Perfumes and perfumery ingredients useful in the present compositions and processes comprise a wide variety of natural and synthetic chemical ingredients, including, but not limited to, aldehydes, ketones, esters, and the like. Also included are various natural extracts and essences which can comprise complex mixtures of ingredients, such as orange oil, lemon oil, rose extract, lavender, musk, patchouli, balsamic essence, sandalwood oil, pine oil, cedar, and the like. Finished perfumes can comprise extremely complex mixtures of such ingredients. Finished perfumes typically comprise from about 0.01% to about 2%, by weight, of the detergent compositions herein, and individual perfumery ingredients can comprise from about 0.0001% to about 90% of a finished perfume composition.

Non-limiting examples of perfume ingredients useful herein include: 7-acetyl-1,2,3,4,5,6,7,8-octahydro-1,1,6,7-tetramethyl naphthalene; ionone methyl; ionone gamma methyl; methyl cedrylone; methyl dihydrojasmonate; methyl 1,6,10-trimethyl-2,5,9-cyclododecatrien-1-yl ketone; 7-acetyl-1,1,3,4,4,6-hexamethyl tetralin; 4-acetyl-6-tert-butyl-1,1-dimethyl indane; para-hydroxy-phenyl-butanone; benzophenone; methyl beta-naphthyl ketone; 6-acetyl-1,1,2,3,3,5-hexamethyl indane; 5-acetyl-3-isopropyl-1,1,2,6-tetramethyl indane; 1-dodecanal, 4-(4-hydroxy-4-methylpentyl)-3-cyclohexene-1-carboxaldehyde; 7-hydroxy-3,7-dimethyl octanal; 10-undecen-1-al; iso-hexenyl cyclohexyl carboxaldehyde; formyl tricyclodecane; condensation products of hydroxycitronellal and methyl anthranilate, condensation products of hydroxycitronellal and indol, condensation products of phenyl acetaldehyde and indol; 2-methyl-3-(para-

tert-butylphenyl)-propionaldehyde; ethyl vanillin; heliotropin; hexyl cinnamic aldehyde; amyl cinnamic aldehyde; 2-methyl-2-(para-iso-propylphenyl)-propionaldehyde; coumarin; decalactone gamma; cyclopentadecanolide; 16-hydroxy-9-hexadecenoic acid lactone; 1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethylcyclopenta-gamma-2-benzopyrane; beta-naphthol methyl ether; ambroxane; dodecahydro-3a,6,6,9a-tetramethylnaphtho[2,1b]furan; cedrol, 5-(2,2,3-trimethylcyclopent-3-enyl)-3-methylpentan-2-ol; 2-ethyl-4-(2,2,3-trimethyl-3-cyclopenten-1-yl)-2-buten-1-ol; caryophyllene alcohol; tricyclodecenyl propionate; tricyclodecenyl acetate; benzyl salicylate; cedryl acetate; and para-(tert-butyl) cyclohexyl acetate.

Particularly preferred perfume materials are those that provide the largest odor improvements in finished product compositions containing cellulases. These perfumes include but are not limited to: hexyl cinnamic aldehyde; 2-methyl-3-(para-tert-butylphenyl)-propionaldehyde; 7-acetyl-1,2,3,4,5,6,7,8-octahydro-1,1,6,7-tetramethylnaphthalene; benzyl salicylate; 7-acetyl-1,1,3,4,4,6-hexamethyl tetralin; para-tert-butyl cyclohexyl acetate; methyl dihydro jasmonate; beta-naphthol methyl ether; methyl beta-naphthyl ketone; 2-methyl-2-(para-iso-propylphenyl)-propionaldehyde; 1,3,4,6,7,8-hexahydro-4,6,6,7,8,8-hexamethyl-cyclopenta-gamma-2-benzopyrane; dodecahydro-3a,6,6,9a-tetramethylnaphtho[2,1b]furan; anisaldehyde; coumarin; cedrol; vanillin; cyclopentadecanolide; tricyclodecenyl acetate; and tricyclodecenyl propionate.

Other perfume materials include essential oils, resinoids, and resins from a variety of sources including, but not limited to: Peru balsam, Olibanum resinoid, styrax, labdanum resin, nutmeg, cassia oil, benzoin resin, coriander and lavandin. Still other perfume chemicals include phenyl ethyl alcohol, terpeneol, linalool, linalyl acetate, geraniol, nerol, 2-(1,1-dimethylethyl)-cyclohexanol acetate, benzyl acetate, and eugenol. Carriers such as diethylphthalate can be used in the finished perfume compositions.

Other Ingredients - A wide variety of other ingredients useful in detergent compositions can be included in the compositions herein, including other active ingredients, carriers, hydrotropes, processing aids, dyes or pigments, solvents for liquid formulations, solid fillers for bar compositions, etc. If high sudsing is desired, suds boosters such as the C₁₀-C₁₆ alkanolamides can be incorporated into the compositions, typically at 1%-10% levels. The C₁₀-C₁₄ monoethanol and diethanol amides illustrate a typical class of such suds boosters. Use of such suds boosters with high sudsing adjunct surfactants such as the amine oxides, betaines and sultaines noted above is also advantageous. If desired, water-soluble magnesium and/or calcium salts such as MgCl₂, MgSO₄, CaCl₂, CaSO₄ and the like, can be added at levels of, typically, 0.1%-2%, to provide additional suds and to enhance grease removal performance.

A porous hydrophobic silica (trademark SIPERNAT D10, DeGussa) is admixed with a proteolytic enzyme solution containing 3%-5% of C₁₃₋₁₅ ethoxylated alcohol (EO 7) nonionic surfactant. Typically, the enzyme/surfactant solution is 2.5 X the weight of silica. The resulting powder is dispersed with stirring in silicone oil (various silicone oil viscosities in the range of 500-12,500 can be used). The resulting silicone oil dispersion is emulsified or otherwise added to the final detergent matrix. By this means, ingredients such as the aforementioned enzymes, photoactivators, dyes, fluorescers, fabric conditioners and hydrolyzable surfactants can be "protected" for use in detergents, including liquid laundry detergent compositions.

Liquid detergent compositions can contain water and other solvents as carriers. Low molecular weight primary or secondary alcohols exemplified by methanol, ethanol, propanol, and isopropanol are suitable. Monohydric alcohols are preferred for solubilizing surfactant, but polyols such as those containing from 2 to about 6 carbon atoms and from 2 to about 6 hydroxy groups (e.g., 1,3-propanediol, ethylene glycol, glycerine, and 1,2-propanediol) can also be used. The compositions may contain from 5% to 90%, typically 10% to 50% of such carriers.

The detergent compositions herein will preferably be formulated such that, during use in aqueous cleaning operations, the wash water will have a pH of between about 6.5 and about 11, preferably between about 7.5 and 10.5. Liquid dishwashing product formulations preferably have a pH between about 6.8 and about 9.0. Laundry products are typically at pH 9-11. Techniques for controlling pH at recommended usage levels include the use of buffers, alkalis, acids, etc., and are well known to those skilled in the art.

Liquid Detergents

The manufacture of heavy duty liquid detergent compositions, especially those designed for fabric laundering, which comprise a non-aqueous carrier medium can be prepared according to the disclosures of U.S. Patents 4,753,570; 4,767,558; 4,772,413; 4,889,652; 4,892,673; GB-A-2,158,838; GB-A-2,195,125; GB-A-2,195,649; U.S. 4,988,462; U.S. 5,266,233; EP-A-225,654 (6/16/87); EP-A-510,762 (10/28/92); EP-A-540,089 (5/5/93); EP-A-540,090 (5/5/93); U.S. 4,615,820; EP-A-565,017 (10/13/93); EP-A-030,096 (6/10/81), incorporated herein by reference. Such compositions can contain various particulate deterative ingredients stably suspended therein. Such non-aqueous compositions thus comprise a LIQUID PHASE and, optionally but preferably, a SOLID PHASE, all as described in more detail hereinafter and in the cited references. The modified polyamine fabric appearance agents are incorporated in the compositions at

the levels and in the manner described hereinabove for the manufacture of other laundry detergent compositions.

The compositions of this invention can be used to form aqueous washing solutions for use in the laundering of fabrics. Generally, an effective amount of such compositions is added to water, preferably in a conventional fabric laundering automatic washing machine, to form such aqueous laundering solutions. The aqueous washing solution so formed is then contacted, preferably under agitation, with the fabrics to be laundered therewith.

An effective amount of the liquid detergent compositions herein added to water to form aqueous laundering solutions can comprise amounts sufficient to form from about 500 to 7,000 ppm of composition in aqueous solution. More preferably, from about 800 to 3,000 ppm of the detergent compositions herein will be provided in aqueous washing solution.

The following examples are illustrative of the present invention, but are not meant to limit or otherwise define its scope. All parts, percentages and ratios used herein are expressed as percent weight unless otherwise specified.

In the following Examples all levels are quoted as % by weight of the composition.

EXAMPLE I

Preparation of PEI 600 E₂₀

The ethoxylation is conducted in a 2 gallon stirred stainless steel autoclave equipped for temperature measurement and control, pressure measurement, vacuum and inert gas purging, sampling, and for introduction of ethylene oxide as a liquid. A ~20 lb. net cylinder of ethylene oxide (ARC) is set up to deliver ethylene oxide as a liquid by a pump to the autoclave with the cylinder placed on a scale so that the weight change of the cylinder could be monitored.

A 250 g portion of polyethyleneimine (PEI) (Nippon Shokubai, having a listed average molecular weight of 600 equating to about 0.417 moles of polymer and 6.25 moles of nitrogen functions) is added to the autoclave. The autoclave is then sealed and purged of air (by applying vacuum to minus 28" Hg followed by pressurization with nitrogen to 250 psia, then venting to atmospheric pressure). The autoclave contents are heated to 130 °C while applying vacuum. After about one hour, the autoclave is charged with nitrogen to about 250 psia while cooling the autoclave to about 105 °C. Ethylene oxide is then added to the autoclave incrementally over time while closely monitoring the autoclave pressure, temperature, and ethylene oxide flow rate. The ethylene oxide pump is turned off and cooling is applied to limit any temperature increase resulting from any

reaction exotherm. The temperature is maintained between 100 and 110 °C while the total pressure is allowed to gradually increase during the course of the reaction. After a total of 275 grams of ethylene oxide has been charged to the autoclave (roughly equivalent to one mole ethylene oxide per PEI nitrogen function), the temperature is increased to 110 °C and the autoclave is allowed to stir for an additional hour. At this point, vacuum is applied to remove any residual unreacted ethylene oxide.

Next, vacuum is continuously applied while the autoclave is cooled to about 50 °C while introducing 135 g of a 25% sodium methoxide in methanol solution (0.625 moles, to achieve a 10% catalyst loading based upon PEI nitrogen functions). The methoxide solution is sucked into the autoclave under vacuum and then the autoclave temperature controller setpoint is increased to 130 °C. A device is used to monitor the power consumed by the agitator. The agitator power is monitored along with the temperature and pressure. Agitator power and temperature values gradually increase as methanol is removed from the autoclave and the viscosity of the mixture increases and stabilizes in about 1 hour indicating that most of the methanol has been removed. The mixture is further heated and agitated under vacuum for an additional 30 minutes.

Vacuum is removed and the autoclave is cooled to 105 °C while it is being charged with nitrogen to 250 psia and then vented to ambient pressure. The autoclave is charged to 200 psia with nitrogen. Ethylene oxide is again added to the autoclave incrementally as before while closely monitoring the autoclave pressure, temperature, and ethylene oxide flow rate while maintaining the temperature between 100 and 110 °C and limiting any temperature increases due to reaction exotherm. After the addition of approximately 5225 g of ethylene oxide (resulting in a total of 20 moles of ethylene oxide per mole of PEI nitrogen function) is achieved over several hours, the temperature is increased to 110 °C and the mixture stirred for an additional hour.

The reaction mixture is then collected in nitrogen purged containers and eventually transferred into a 22 L three neck round bottomed flask equipped with heating and agitation. The strong alkali catalyst is neutralized by adding 60 g methanesulfonic acid (0.625 moles). The reaction mixture is then deodorized by passing about 100 cu. ft. of inert gas (argon or nitrogen) through a gas dispersion frit and through the reaction mixture while agitating and heating the mixture to 130 °C.

The final reaction product is cooled slightly and collected in glass containers purged with nitrogen.

In other preparations the neutralization and deodorization is accomplished in the reactor before discharging the product.

EXAMPLE II

The following describe liquid detergent compositions according to the present invention:

Ingredients	Weight %			
	A	B	C	D
Polyhydroxy coco-fatty acid amide	3.5	3.5	3.5	3.5
NEODOL 23-9 ¹	2.0	2.0	2.0	2.0
C ₂₅ Alkyl ethoxylate sulphate	19.0	19.0	19.0	19.0
C ₂₅ Alkyl sulfate	--	--	3.5	2.0
C ₁₀ -Aminopropylamide	--	0.5	1.5	0.5
Citric acid	3.0	5.0	3.0	5.0
Tallow fatty acid	2.0	--	2.0	--
Ethanol	3.5	3.5	3.5	3.5
Propanediol	6.0	6.0	6.0	6.0
Monomethanol amine	0.5	0.5	0.5	0.5
Sodium hydroxide	3.0	2.5	3.5	2.5
Sodium p-toluene sulfonate	2.5	2.5	2.5	2.5
Borax	2.5	2.5	2.5	2.5
Protease ²	0.8	0.8	0.8	0.8
Lipolase ³	0.1	0.1	0.1	0.1
Duramyl ⁴	0.1	0.1	--	--
α -amylase ⁵	--	--	0.1	0.1
CAREZYME	0.05	0.05	0.05	0.05
Optical Brightener ⁶	0.1	0.1	0.1	0.1
Modified Polyamine ⁷	1.2	1.2	1.2	1.2
Soil release agent ⁸	0.2	0.2	0.2	0.2
Fumed silica	0.1	0.1	0.1	0.1
Minors, aesthetics, water	Balance to 100%			

1. C₁₂-C₁₃ alkyl E9 ethoxylate as sold by Shell Oil Co.
2. *Bacillus amyloliquefaciens* subtilisin as described in WO 95/10615 published April 20, 1995 by Genencor International.
3. Derived from *Humicola lanuginosa* and commercially available from Novo.
4. Disclosed in WO 9510603 A and available from Novo.
5. α -amylase disclosed herein, including TERMAMYL[®], RAPIDASE[®], FUNGAMYL[®], DURAMYL[®].

6. Brightener is selected from Brightener 49 (Tinopal CBS), inopal UNPA, Tinopal CBS, Tinopal 5BM, Artic White CC, Artic White CWD, 2-(4-styryl-phenyl)-2H-naphtho[1,2-d]triazoles; 4,4'-bis-(1,2,3-triazol-2-yl)-stilbenes, 4,4'-bis(styryl)bisphenyls, and amino-coumarins.
7. PEI 600 E₂₀ as described above.
8. Terephthalate co-polymer as disclosed in U.S. Patent 4,968,451, Scheibel et al., issued November 6, 1990.

EXAMPLE III

The following describe liquid detergent compositions according to the present invention:

Ingredients	Weight %		
	A	B	C
Polyhydroxy coco-fatty acid amide	3.5	3.5	--
NEODOL 23-9 ¹	2.0	2.0	2.0
C ₂₅ Alkyl ethoxylate sulphate	15.0	15.0	15.0
C ₂₅ Alkyl sulfate	2.0	2.0	--
C ₁₀ -Aminopropylamide	--	--	0.5
Linear alkylbenzene sulfonate	4.0	4.0	4.0
Citric acid	3.0	5.0	5.0
Tallow fatty acid	2.0	2.0	2.0
Ethanol	3.4	3.4	3.4
Propanediol	6.0	6.0	6.0
Monomethanol amine	0.5	0.5	0.5
Sodium hydroxide	3.0	2.5	2.5
Sodium p-toluene sulfonate	2.5	2.5	2.5
Borax	2.5	2.5	2.5
Protease ²	0.8	0.8	0.8
Lipolase ³	0.1	0.1	0.1
α -amylase ⁵	0.1	0.1	0.1
CAREZYME	0.05	0.05	0.05
Optical Brightener	0.1	0.1	0.1
Modified Polyamine ⁶	1.2	1.2	1.2

Ethoxylated tetraethylene-pentamine	3.0	3.0	3.0
Soil release agent ⁷	0.2	0.2	0.2
Fumed silica	0.1	0.1	0.1
Acrylic acid/maleic acid co-polymer	--	--	0.05
Ethylenediamine disuccinate chelant	--	1.0	--
Fabric Integrity agents ⁸	2.0	3.5	0.75
Minors, aesthetics, water	Balance to 100%		

1. C₁₂-C₁₃ alkyl E9 ethoxylate as sold by Shell Oil Co.
2. *Bacillus amyloliquefaciens* subtilisin as described in WO 95/10615 published April 20, 1995 by Genencor International.
3. Derived from *Humicola lanuginosa* and commercially available from Novo.
5. α -amylase disclosed herein, including TERMAMYL[®], RAPIDASE[®], FUNGAMYL[®], DURAMYL[®].
6. PEI 600 E₂₀ as described above.
7. Terephthalate co-polymer as disclosed in U.S. Patent 4,968,451, Scheibel et al., issued November 6, 1990.
8. Fabric integrity agents selected from prill/fuzz reduction agents, antiredeposition agents, antifading agents, dye fixatives, and mixtures thereof.

Ingredients	Weight %		
	D	E	F
Polyhydroxy coco-fatty acid amide	4.0	5.0	5.0
NEODOL 23-9 ¹	4.0	4.0	2.0
C ₂₅ Alkyl ethoxylate sulphate	4.0	17.0	25.0
C ₂₅ Alkyl sulfate	14.0	7.0	-
C ₁₀ -Aminopropylamide	1.0	2.0	1.0
Linear alkylbenzene sulfonate	--	--	4.0
Citric acid	5.0	5.0	5.0
Tallow fatty acid	7.0	5.0	5.0
Ethanol	2.0	5.5	10.0
Propanediol	9.0	8.0	8.0

Monomethanol amine	5.0	9.0	7.0
Sodium hydroxide	2.0	1.5	0.5
Sodium p-toluene sulfonate	0.1	2.0	2.0
Borax	2.0	3.5	3.5
Protease ²	0.2	1.5	1.5
Lipolase ³	0.06	0.2	--
α -amylase ⁵	0.2	0.1	0.1
CAREZYME	--	0.1	0.1
Optical Brightener	0.15	0.1	0.1
Modified Polyamine ⁶	1.2	1.2	1.2
Ethoxylated tetraethylene-pentamine	1.0	3.0	3.0
Soil release agent ⁷	0.2	0.5	0.5
Fumed silica	0.2	0.1	--
Acrylic acid/maleic acid co-polymer	0.05	-	--
Ethylenediamine disuccinate chelant	1.0	0.5	--
Fabric Integrity agents ⁸	1.0	1.5	--
Minors, aesthetics, water	Balance to 100%		

1. C₁₂-C₁₃ alkyl E9 ethoxylate as sold by Shell Oil Co.
2. *Bacillus amyloliquefaciens* subtilisin as described in WO 95/10615 published April 20, 1995 by Genencor International.
3. Derived from *Humicola lanuginosa* and commercially available from Novo.
5. α -amylase disclosed, including TERMAMYL[®], RAPIDASE[®], FUNGAMYL[®], DURAMYL[®].
6. PEI 600 E₂₀ as described above.
7. Terephthalate co-polymer as disclosed in U.S. Patent 4,968,451, Scheibel et al., issued November 6, 1990.
8. Fabric integrity agents selected from prill/fuzz reduction agents, antiredeposition agents, antifading agents, dye fixatives, and mixtures thereof.

EXAMPLE IV

The following describe structured liquid detergent compositions according to the present invention:

Weight %

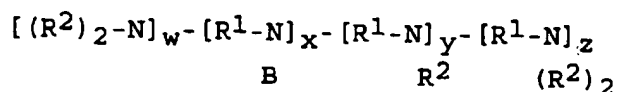
Ingredients	A	B
NEODOL 45-7 ¹	2.0	2.0
C ₂₅ Alkyl ethoxylate sulphate	16.0	16.0
C ₂₅ Alkyl sulfate	--	--
Cationic surfactant ²	5.0	4.0
C12-16 alkyl dimethyl aminoxide	--	1.0
Citric acid	5.0	5.0
Ethanol	--	--
Propanediol	6.4	2.0
Monomethanol amine	--	0.5
Sodium hydroxide	to pH 8.0	to pH 6.7
Borax	2.0	1.0
Protease ³	0.5	1.0
Lipolase ⁴	0.06	0.2
α -amylase ⁵	1.2	0.5
CAREZYME	--	0.5
Optical Brightener	0.2	0.1
Modified Polyamine ⁶	1.0	1.5
Fabric Integrity Agent ⁷	1.0	3.0
Soil release agent ⁸	0.2	0.5
Fumed silica	0.2	0.1
Acrylic acid/maleic acid co-polymer	0.05	-
Ethylenediamine disuccinate chelant	1.0	0.5
Minors, aesthetics, water	Balance to 100%	

1. C₁₄-C₁₅ alkyl E7 ethoxylate as sold by Shell Oil Co.
2. Lauryl trimethyl ammonium chloride
3. *Bacillus amyloliquefaciens* subtilisin as described in WO 95/10615 published April 20, 1995 by Genencor International.
3. Derived from *Humicola lanuginosa* and commercially available from Novo.
5. α -amylase disclosed herein, including TERMAMYL[®], RAPIDASE[®], FUNGAMYL[®], DURAMYL[®].
6. PEI 600 E₂₀ as described above.

7. Fabric integrity agents selected from prill/fuzz reduction agents, antiredeposition agents, antifading agents, dye fixatives, and mixtures thereof.
8. Terephthalate co-polymer as disclosed in U.S. Patent 4,968,451, Scheibel et al., issued November 6, 1990.

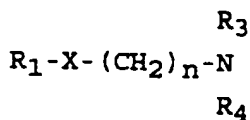
WHAT IS CLAIMED IS:

1. A liquid laundry detergent composition comprising:
 - a) at least 0.1% by weight, of deterative anionic and nonionic surfactants selected from one or more of the following alkyl sulfates, alkyl alkoxy sulfates, linear alkylbenzene sulfonates, polyhydroxy fatty acid amides, and mixtures thereof;
 - b) at least 0.05% by weight, of a water-soluble or dispersible, modified polyamine fabric appearance agent, said agent comprising a polyamine backbone corresponding to the formula:



wherein each R^1 is independently C_2 - C_5 alkylene, alkenylene or arylene; each R^2 is independently H, or a moiety of formula $OH[(CH_2)_xO]_n$, wherein x is from 1 to 8 and n is from 10 to 50; w is 0 or 1; $x+y+z$ is from 5 to 30; and B represents a continuation of this structure by branching; and wherein said polyamine before alkylation has an average molecular weight of from 300 to 1,200; and

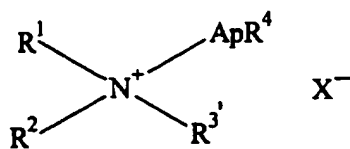
- c) one or more additional deterative additives selected from the group consisting of α -amylase, deterative amine, cationic surfactants, antiredeposition agents, antifading agent, dye fixative agents, prill/fuzzing reducing agents, and mixtures thereof; and wherein said deterative amine is of the formula:



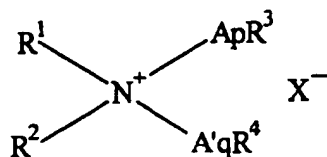
wherein R_1 is a C_6 - C_{12} alkyl group; n is from 2 to 4, X is a bridging group which is selected from NH, CONH, COO, or O or X can be absent; and R_3 and R_4 are individually selected from H, C_1 - C_4 alkyl, or $(CH_2-CH_2-O(R_5))$ wherein R_5 is H or methyl.

2. A composition according to Claim 1 wherein the detergent composition additionally comprises adjunct ingredients selected from the group consisting of builders, optical brighteners, soil release polymers, dye transfer inhibitors, polymeric dispersing agents, non-amylase enzymes, suds suppressers, dyes, perfumes, colorants, filler salts, hydrotropes, and mixtures thereof.

3. A composition according to Claim 2 wherein said adjunct ingredient is a citrate builder; wherein said composition comprises from 2% to 8%, by weight, of said citrate.
4. A composition according to Claim 1 wherein the additional deterative additive is amylase enzyme; wherein said amylase enzyme is selected from the group consisting of:
 - (a) α -amylases characterised by having a specific activity at least 25% higher than the specific activity of Termamyl[®] at a temperature range of 25°C to 55°C and at a pH value in the range of 8 to 10, measured by the Phadebas[®] α -amylase activity assay;
 - (b) α -amylase showing positive immunological cross-reactivity with antibodies raised against an α -amylase having an amino acid sequence corresponding respectively to those α -amylases in (a); and
 - (c) mixtures thereof.
5. A composition according to Claim 1 wherein said amine is selected from the group consisting of octyl amine, hexyl amine, decyl amine, dodecyl amine, C₈-C₁₂ bis(hydroxyethyl)amine, C₈-C₁₂ bis(hydroxyisopropyl)amine, C₈-C₁₂ amido-propyl dimethyl amine, and mixtures.
6. A composition according to Claim 1 wherein the additional deterative additive is a cationic surfactant of the formula:



I

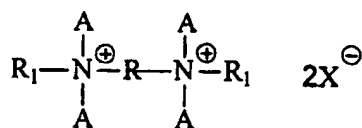


II

wherein R¹ is an alkyl or alkenyl moiety containing from 8 to 18 carbon atoms; R² and R^{3'} are each independently alkyl groups containing from one to about

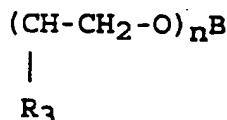
three carbon atoms; R^3 and R^4 can vary independently and are selected from hydrogen, methyl and ethyl; X^- is an anion such as chloride, bromide, methylsulfate, sulfate, or the like, to provide electrical neutrality; A is selected from C_1 - C_4 alkoxy; and for formula I, p is from 2 to 30; and for formula II, p is from 1 to 30 and q is from 1 to 30.

7. A composition according to Claim 1 wherein the additional deterative additive is an antiredeposition agent, said antiredeposition agent is selected from the following formulae:

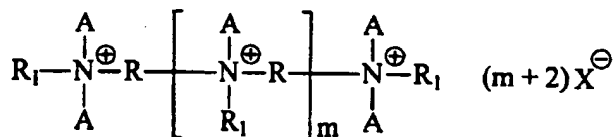


I

where R is selected from linear or branched C_2 - C_{12} alkylene, C_3 - C_{12} hydroxyalkylene, C_4 - C_{12} dihydroxyalkylene, C_8 - C_{12} dialkylarylene, $[(\text{CH}_2\text{CH}_2\text{O})_q\text{CH}_2\text{CH}_2]-$ and $-\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{O}-$ $(\text{CH}_2\text{CH}_2\text{O})_q\text{CH}_2\text{CH}(\text{OH})\text{CH}_2-$ where q is from 1 to 100; each R_1 is independently selected from C_1 - C_4 alkyl, C_7 - C_{12} alkylaryl, or A, wherein A is of the formula:

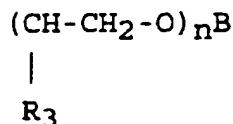


where R_3 is selected from H or C_1 - C_3 alkyl, n is from 5 to 100, and B is selected from H, C_1 - C_4 alkyl, acetyl, or benzoyl; X is a water soluble anion; and



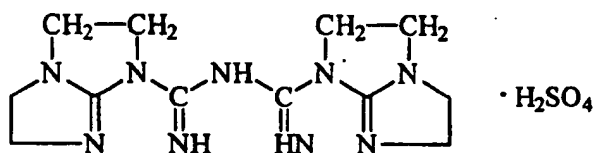
II

where R is selected from linear or branched C_2 - C_{12} alkylene, C_3 - C_{12} hydroxyalkylene, C_4 - C_{12} dihydroxyalkylene, C_8 - C_{12} dialkylarylene, $[(\text{CH}_2\text{CH}_2\text{O})_q\text{CH}_2\text{CH}_2]-$ and $-\text{CH}_2\text{CH}(\text{OH})\text{CH}_2\text{O}-$ $(\text{CH}_2\text{CH}_2\text{O})_q\text{CH}_2\text{CH}(\text{OH})\text{CH}_2-$, where q is from 1 to 100; if present, each R_1 is independently selected from C_1 - C_4 alkyl, C_7 - C_{12} alkylaryl, or A; R_1 may be absent on some nitrogens; however, at least three nitrogens must be quaternized; A is of the formula:



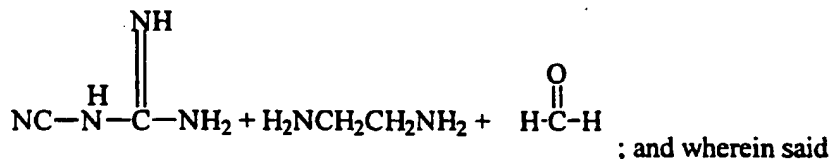
where R_3 is selected from H or C_1 - C_3 alkyl, n is from 5 to 100, and B is selected from H, C_1 - C_4 alkyl, acetyl, or benzoyl; m is from 1 to 4, and X is a water soluble anion.

8. A composition according to Claim 1 wherein the additional deterative additive is an antifading agent comprising from 0.1% to 5% by weight of a dye fixative selected from the group consisting of Cassofix FRN-300[®], Sandofix SWE[®], Sandofix WA[®], Tinofix EW[®], Polymer VRN[®], Sandolec CF[®], Sandolec WA[®], Sandolec CT[®], Sandolec CS[®] and Sandolec Cl[®]; wherein said Sandofix SWE[®] has the formula:



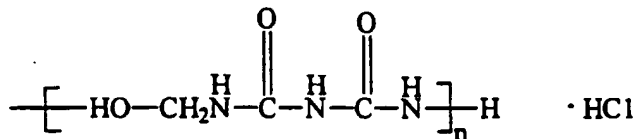
; and wherein said

Cassofix FRN-300[®] polymer is prepared from monomers having the following structures:

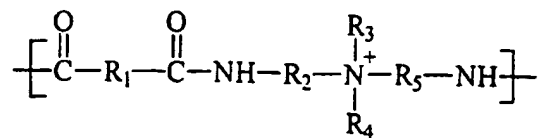


; and wherein said

Sandofix WA[®] polymer has the following structure:



9. A composition according to Claim 1 wherein the additional deterative additive is a pill/fuzz reduction agent comprising from 0.1% to 8% by weight of a polyamide-polyamine fabric treatment agent formed from repeating units of the structural formula:



wherein R_1 , R_2 , and R_5 are each independently C_{1-4} alkylene, C_{1-4} alkarylene or arylene, or wherein R_1 can be eliminated; R_3 is H, epichlorohydrin, an azetidinium group, an epoxypropyl group, or a dimethylaminohydroxypropyl group; and, R_4 is H, C_{1-4} alkyl, C_{1-4} alkaryl, or aryl; and said R_4 groups may optionally be condensed with C_{1-4} alkylene oxide.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 97/06989

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 C11D3/37

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C11D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 95 32272 A (PROCTER & GAMBLE) 30 November 1995 cited in the application see page 4, line 10 - page 6, line 34 see page 19, line 1 - page 20, line 35; claims ---	1-3
X	US 4 891 160 A (VANDER MEER JAMES M) 2 January 1990 cited in the application see claims ---	1-3
X	EP 0 206 513 A (PROCTER & GAMBLE ; PROCTER & GAMBLE EUROP (BE)) 30 December 1986 cited in the application see claims ---	1-3

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- *P* document published prior to the international filing date but later than the priority date claimed

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Date of the actual completion of the international search

26 September 1997

Date of mailing of the international search report

08. 10. 97

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 97/06989

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>DATABASE WPI Section Ch, Week 8920 Derwent Publications Ltd., London, GB; Class D16, AN 89-147480 XP002039752 & JP 01 090 296 A (KAO CORP) , 6 April 1989 see abstract</p> <p>---</p>	1-3,5,7
A	<p>DATABASE WPI Section Ch, Week 9606 Derwent Publications Ltd., London, GB; Class A14, AN 96-056303 XP002041928 & JP 07 316 590 A (LION CORP) , 5 December 1995 see abstract</p> <p>-----</p>	1

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/US 97/06989

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9532272 A	30-11-95	AU 2387095 A CA 2189749 A EP 0760846 A US 5565145 A	18-12-95 30-11-95 12-03-97 15-10-96
US 4891160 A	02-01-90	US 4597898 A AU 575034 B AU 2280283 A CA 1220395 A DK 20491 A EG 17032 A EP 0112593 A GB 2133415 A,B GB 2175597 A,B GB 2180249 A,B HK 58390 A HK 58790 A HK 74590 A JP 1773204 C JP 4054719 B JP 59166598 A	01-07-86 21-07-88 28-06-84 14-04-87 06-02-91 30-10-93 04-07-84 25-07-84 03-12-86 25-03-87 10-08-90 10-08-90 28-09-90 14-07-93 01-09-92 19-09-84
EP 0206513 A	30-12-86	CA 1309925 A	10-11-92